STATE OF CALIFORNIA
AIR RESOURCES BOARD

Proposed Amendments to California's Heavy-Duty On-Board Diagnostic Regulations	**)))**	**Hearing Date: November 15, 2018** **Agenda Item: (18-9-4)**

COMMENTS OF THE TRUCK AND ENGINE MANUFACTURERS ASSOCIATION

November 5, 2018

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<u>Introduction</u>

For the third time since 2005, the California Air Resources Board (CARB) is proposing to amend and significantly expand the on-board diagnostic (OBD) requirements and associated penalties applicable to heavy-duty (HD) on-highway (OH) engines and vehicles. The Truck and Engine Manufacturers Association (EMA) hereby submits its comments in opposition to CARB's pending proposal to increase the already onerous burdens and costs associated with CARB's HD OBD regulations and requirements.

As detailed below, CARB's HD OBD program has expanded to the point where it is cost-prohibitive under any reasonable metric for assessing the cost-effectiveness of mobile sources emission-control regulations, and therefore outside the scope of CARB's authority. Similarly, the excessive costs and burdens of the HD OBD program amendments, violate the preemption-waiver requirements established under the federal Clean Air Act. Accordingly, the Board should not approve the pending proposal to further augment CARB's HD OBD program, but instead should direct CARB staff to conduct and submit a detailed, comprehensive and cumulative cost-effectiveness study (in the aggregate, not in a piecemeal fashion) of the entire current HD OBD program as it has expanded since 2005. Only after a careful assessment of that rigorous study should the Board consider how best to amend and streamline — not expand — the HD OBD program.

EMA is the trade association that represents the world's leading manufacturers of internal combustion engines, including the HD engines that are the subject of the pending, expansive HD OBD amendments. EMA also represents the world's leading manufacturers of the HDOH vehicles in which those HD engines are installed. Accordingly, EMA and its members have a direct and significant stake in the outcome of the pending rulemaking process, and have been active participants in the workgroup and workshop meetings that have led up to CARB staff's proposal. Unfortunately, and despite the numerous comments and suggestions from EMA aimed at fashioning more reasonable HD OBD regulations, CARB's proposal remains overly-broad, unduly burdensome and increasingly cost-prohibitive. Consequently, and as explained below, EMA strongly opposes the pending amendments, which, among other things, exceed CARB's delegated authority and violate the necessary prerequisites for obtaining a waiver of federal preemption under the federal Clean Air Act.

In assessing EMA's comments, the Board should take special note of a potential outcome of this rulemaking process, which is just one in a planned suite of HDOH engine regulations that CARB staff intend to bring to the Board for adoption before the end of 2019. More specifically, it is increasingly apparent that the full array of CARB staff's envisioned California-only HDOH engine regulations (e.g., expanded OBD requirements and penalties, expanded in-use testing requirements, dramatically lower tailpipe NO_x standard, new low-load certification test cycle, and enhanced useful life and durability requirements) could lead to a fracture of the HDOH engine and vehicle market, with multiple manufacturers potentially being forced to focus on EPA-certified 49-state products, thereby leaving a void of CARB-compliant products in the State, and a significant increase in the costs of any remaining CARB-compliant products. That same CARB-envisioned series of California-only regulations also could lead to a very significant "pre-buy/no-buy" reaction among fleet owners and operators in California, which would frustrate and retard the attainment of air quality objectives, and which would deter manufacturers from investing in and delivering next-generation technologies into the State. While that outcome is anathema to EMA, which has a core mission to promote nationwide harmonized regulations for mobile sources, it is the outcome that appears more and more likely as CARB staff move forward to implement the envisioned multi-pronged and unique suite of regulations for HDOH engines and vehicles in California. The Board should consider carefully the ramifications of that potential outcome.

The Bigger Picture:
The Opportunity for a Regulatory Paradigm Shift

The HD truck and engine manufacturing industry is strongly committed to pursuing additional emission reductions and additional improvements in air quality, both in California and nationwide. For the past 40-plus years, EMA's members have helped to develop and implement increasingly effective and advanced emission control technologies and standards, which have reduced NO_x and PM emissions by more than 95% from uncontrolled levels. Significantly, while the levels of those standards have been dramatically reduced, the basic structure of those standards and regulations - - which are based on laboratory certification testing conducted using prescriptive engine duty cycles and testing conditions, and are subject to detailed prescriptive on-board diagnostic requirements - - have remained largely the same over the past 40 years.

Advancements in engine and vehicle technologies - - including advanced emission sensors, real-time data-processing and telematics capabilities, and geofencing strategies - - afford a unique opportunity to reimagine the regulatory paradigm for the control of emissions from HDOH vehicles and engines. It now is possible to envision next-tier emission control regulations that move from a prescriptive-based approach to a robust and comprehensive performance-based approach. EMA's members are committed to exploring and implementing that type of regulatory paradigm shift that provides increased focus on the real-world emissions performance that would be the compliance benchmark under that new paradigm.

CARB's current suite of prescriptive-based emission-control regulations have become increasingly expensive and complex with diminishing corresponding real-world emissions benefits. With that in mind, EMA members are actively working on developing a new performance-based paradigm that would focus on monitoring and assessing the actual real-world emissions performance of vehicles in real-time over a suitable duration of vehicle activity, such as a shift-day, to ensure that aggregate shift-day emissions for HD vehicles equipped with engines in a given engine family remain below a new, reduced in-use emission metric.

Such a program would involve the regular reporting and sharing of in-use emissions data with regulatory agencies, and would allow for better correlation between reduced emission standards and reduced real-world emissions. It also would allow for the recognition, reporting and correction of any in-use compliance issues, as well as the identification and repair of high-emitters. And, just as significant, such a new performance-based program would allow for the elimination or simplification of a number of current prescriptive-based regulations.

It will take time and effort to fully develop and implement that type of paradigm shift from prescriptive-based regulations to performance-based regulations. As a result, EMA expects that the first realistic timeframe to target for the implementation of such a program would be the 2027 model year.

That said, EMA recognizes that California needs to achieve additional emissions reductions in advance of 2027. To that end, EMA also has developed an interim low-NO_x proposal - - which would be implemented on a nationwide basis in 2024 - - that would result in a 25% reduction in NO_x emissions from HDOH engines and vehicles. Significantly, that interim nationwide program would yield more tons of reductions of NO_x emissions than under the prescriptive-based California-only low-NO_x standards that CARB staff currently are considering.

The pending HD OBD amendments amount to another round of regulatory directives that will increase the costs and complexity of prescriptive-based measures, while further reducing their already diminished cost-effectiveness. The complexity and expense of those measures also will consume a significant percentage of manufacturers' engineering resources and expertise that otherwise could be directed toward developing and optimizing a new performance-based paradigm. Accordingly, as detailed below, EMA urges the Board to defer adoption of this matter today and, instead, to direct CARB staff to report back on their recommendations on the possibility of a future performance-based regulation scheme and on interim low-NO_x emission reduction. In addition, the Board should ask the staff to conduct a thorough cumulative cost-benefit analysis of the HD OBD program as a whole, and then to report back on how that program could be streamlined to foster the envisioned transition to a new performance-based regulatory paradigm in the 2027 timeframe.

Summary of Comments

The Board Should Not Approve CARB Staff's Proposed Expansion of the HD OBD Program

- CARB should work with EMA and other stakeholders to develop next-tier HDOH emission standards that would represent a paradigm shift from prescriptive-based regulations to performance-based regulations
- The proposed HD OBD amendments amount to costly and complex additions to a prescriptive-based program that is an impediment to the development and implementation of the paradigm shift, and which also have a negative benefit-to-cost ratio

- The proposed expansion of the HD OBD program would consume a significant percentage of manufacturers' engineering resources and expertise that otherwise could be directed toward the development of a robust performance-based emissions control program for HDOH engines and vehicles focused on real-world real-time emissions performance
- CARB's current HD OBD program is by far the most expensive certification-related program, and is substantially more onerous and costly than EPA's HD OBD program
- HHD engine manufacturers are each spending approximately $10.6 million per year to comply with CARB HD OBD regulations, and are spending an additional $1.5 million per year to comply with CARB's current HD OBD manufacture self-testing (MST) requirements
- CARB's HD OBD regulations are unduly burdensome and complex (accounting for more than 200 pages of regulatory text) and add nearly $2,700 to the cost of each HHD engine sold in California
- CARB's proposed HD OBD amendments would increase the scope of the HD OBD program by 400% (including through new non-germane NO_x/fuel-consumption tracking and binning requirements), and would increase the OBD-related deficiency fine structure by at least 300%
- CARB's proposed expansion of the HD OBD program will add another $2,448 to the current cost of $2,700 applicable to each HHD engine sold in California (the increased deficiency fines alone will be as high as $1,500 per engine)
- There are no material additional emission-reduction benefits from CARB's HD OBD program (i.e., CARB projects that the program will still only eliminate 14 pounds (not tons) of PM over the lifetime of a HHD engine)
- Consequently, the "cost-effectiveness" of CARB's HD OBD regulations is more than $10,000,000 per ton of PM reduced (it is still more than $5,000,000 per ton if only half of the costs are allocated to PM reductions); that is well beyond the scale of any reasonable cost-effectiveness metric
- CARB staff have underestimated the costs of the HD OBD regulations, including in their preemption waiver requests to EPA, by more than an order of magnitude (i.e., CARB claims that the total aggregate cost is $207 per engine)
- The growing and disproportionate cost and complexity of CARB's HD OBD regulations could drive HD engine manufacturers toward 49-state certifications under EPA's regulations, which would have significant adverse impacts on California's businesses and air quality
- Significantly, and despite multiple requests from the industry, CARB staff have never conducted a cumulative aggregate cost assessment of the HD OBD program; CARB staff have only estimated the incremental costs each time they expand the program
- The Board should defer the proposed expansion of the HD OBD regulations, and should instead direct CARB staff to conduct a thorough cumulative cost analysis, and report back on all of the aggregate costs of the HD OBD program, and how that program might be streamlined to comport with a new performance-based paradigm

CARB's HD OBD Regulations

CARB adopted its first HD OBD regulations in 2005, and those regulations have grown exponentially since then to the point where they now consume more than 200 pages of regulatory text. (See Cal. Code of Reg., title 13, §§ 1971.1 and 1971.5.) Since 2013, CARB's HD OBD regulations have required engine manufacturers to install a fully compliant HD OBD system on all HDOH engines used in vehicles having a gross vehicle weight rating greater than 14,000 pounds.

The CARB-mandated HD OBD systems are comprised of complex computer hardware and software systems, emissions sensors, and electronic monitors that continually assess the status and performance of virtually all of the various HDOH engine components that could affect emissions. The HD OBD regulations require engine manufacturers to monitor for engine misfire as well as emissions-related malfunctions in numerous engine systems, including fuel and fuel injection, catalyst performance, turbocharging, EGR functions, particulate trap filter performance, engine cooling capabilities, and variable valve timing and control. The HD OBD systems must have calibrated emission control monitors (calibrated to emission levels below the applicable emission standards) so that emission-component malfunctions can be detected before emission levels exceed established thresholds that are set at levels correlated to the certification emission standards. The HD OBD regulations also require that OBD systems monitor numerous other emissions-related components and systems for proper performance, response-time and functionality. All in, the CARB-mandated HD OBD systems currently require more than 100 data-stream elements and monitors, tracking all aspects of engine and aftertreatment system performance, and necessitating highly complex and costly software systems, electronic control and data processing units, and a broad array of sensors to monitor temperature, pressure, voltage emission, and numerous other data elements pertaining to an engine's operation and functionality.

In order to obtain an Executive Order from CARB authorizing the sale of HDOH engines in California—and, as a practical matter, in the rest of the United States, at least up to this point, as explained below—engine manufacturers annually must submit thousands of pages of design specifications to CARB describing the manner in which their HD OBD systems comply with the hundreds of pages of CARB regulations. Typically, CARB staff will certify HD OBD systems only after months of review and numerous requests for more specificity regarding the HD OBD systems' behavior under various hypothetical conditions. CARB's HD OBD requirements are far and away the most costly and time-consuming certification-testing regulations imposed on HDOH engine manufacturers before they can sell their products into commerce. Significantly, those CARB requirements far exceed any corollary EPA requirements.

In addition to the HD OBD certification requirements, CARB's HD OBD regulations also include a "manufacturer self-testing" or "MST" program. Under that MST program, manufacturers are required to repurchase several 3-4 year-old in-use HDOH engines from HDOH vehicle owners, so that those reacquired engines (potentially ranging in number from 3 to 30 per-year per-manufacturer) can be removed from their vehicles and shipped back to the manufacturers' testing facilities for evaluation. The specific testing required under the MST program involves removing the numerous original OBD-related parts and then installing, on an iterative one-by-one basis, multiple deliberately defective OBD-related parts to assess whether the relevant components of the OBD system will illuminate a malfunction indicator lamp ("MIL") before any applicable emission thresholds are exceeded. Failures of this MST testing process — which consumes many months of engine research laboratory test cell time and hundreds if not thousands of engineering man-hours — can lead to "voluntary" or CARB-mandated engine recalls. [1]

As noted above, and not surprisingly, CARB's HD OBD regulations are by far the most complex and expensive prescriptive-based regulations relating to the certification of HDOH engines, even before considering the pending amendments. Nonetheless, as part of its continuing "biennial review" process, CARB is again seeking to amend and significantly expand its HD OBD regulations. Under the pending additive amendments, CARB is proposing to require, among other things, that manufacturers: (i) monitor an additional 467 data-stream parameters (amounting to more than a 400% increase), which will require extensive new upgrades to engine software and hardware/data-storage systems; (ii) track and "bin" (based on numerous vehicle speed and engine power parameters) NO_x emissions and fuel-consumption data on a real-time, 100-hour and cumulative basis; and (iii) pay fines with respect to any OBD monitoring function that cannot meet CARB's specifications, which fines are likely to add up to $1,500 to the cost of HDOH engines sold in California, not including the additional cost increases for the required engine software and hardware upgrades. Thus, the cost-prohibitive and thereby infeasible nature of CARB's prescriptive-based HD OBD regulations continues to increase unabated.

There is one aspect of the pending HD OBD amendments that warrants special mention, as it amounts to an important exception to CARB's continued expansion of the HD OBD program. More specifically, CARB is proposing to adopt a number of amendments to reduce the burden and costs of the MST program by incorporating several EMA-recommended revisions, including reducing the number of OBD monitors to be tested from approximately 30 down to 15 (an approximate 50% reduction), expanding the range of vehicles and engines that can be tested (thereby making it easier for manufacturers to find and recruit in-use engines for testing), and providing additional relief for the testing of deficient OBD threshold monitors.

EMA and its members sincerely appreciate the efforts that CARB staff have made to alleviate the costs and burdens of the MST program. And, while EMA's comments are not supportive of the overall HD OBD program or the entire package of the pending amendments, EMA does not want to overlook the work that CARB has undertaken to address at least some of

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[1] Significantly, when U.S. EPA adopted its own HD OBD regulations in 2009, the Agency required HDOH engine manufacturers to conduct OBD demonstration testing *before* the certification of engines for sale into commerce, not *after*. In fact, the Agency determined that the type of post-sale MST program that CARB has adopted — which requires engine manufacturers to purchase in-use vehicles, remove the HDOH engines from those vehicles, and ship those engines back to the manufacturers' facilities for extensive OBD/MIL testing — would be inherently cost-prohibitive. More specifically, in the preamble to the final rule for its own HD OBD regulations, the Agency stated as follows:

> Given the difficulty and expense in removing an in-use engine from a vehicle for engine dynamometer testing, this [pre-certification] demonstration testing [that EPA is requiring] will likely represent nearly all of the OBD emission testing that would ever be done on those engines. Requiring a manufacturer who is fully equipped to do such testing, and already has the engines on engine dynamometers for emissions testing . . . provides invaluable and, in a practical sense, otherwise unobtainable proof of compliance with the OBD emission thresholds. (74 FR at 8347.)

Thus, U.S. EPA has concluded previously that the type of MST testing that CARB requires under its HD OBD program is inherently cost-prohibitive and unreasonable.

EMA's more significant concerns relating to the MST program.

That said, it still remains that the MST program is and will be very expensive and time consuming, and is still likely to cost each HD engine manufacturer approximately $1 million per year to complete, not $363,717 per year as CARB estimates in the pending ISOR. (2018 ISOR, p. 187.) Consequently, and notwithstanding the positive changes to the MST program that CARB is proposing (and which EMA appreciates), the HD OBD program, in the aggregate, continues to be cost-prohibitive.

The cost-prohibitive nature of CARB's HD OBD regulations is compounded by the fact that, at least up to this point, CARB's regulations have amounted to de facto nationwide standards. More specifically, EPA's own HD OBD regulations (which are not as onerous or costly as CARB's, and which do not include, among other things, an MST program or "OBD deficiency" fines) specify that "[a]s an alternative to demonstrating compliance with the provisions of [EPA's HD OBD requirements], a manufacturer may demonstrate how the OBD system they have designed to comply with California [HD] OBD requirements . . . also complies with the intent of [EPA's regulations]." 40 CFR § 86.010-18(a)(5). In practice, however, that "option" to demonstrate compliance with EPA's HD OBD requirements is not really an option at all. Rather, EPA has ceded its authority to enforce its own HD OBD regulations to CARB. In that regard, EPA currently requires that manufacturers provide EPA with evidence of CARB's approval that the manufacturers' HD OBD systems meet CARB requirements *before* EPA will issue a federal Certificate of Conformity. In fact, EPA currently does not have a process or the requisite personnel to make its own independent determinations of whether a manufacturer's engine family complies with EPA's HD OBD regulations.

The pending HD OBD amendments, among other things, could force a change to that regulatory dynamic. Faced with increasingly cost-prohibitive HD OBD requirements in California, HDOH engine manufacturers and EPA leadership may be compelled to take the necessary steps and deploy the necessary resources to ensure that manufacturers seeking 49-state certifications for their engines and OBD systems could receive them in a prompt and orderly fashion. Stated differently, CARB's pending suite of unique and unduly onerous HDOH engine regulations, including the pending HD OBD amendments, could lead manufacturers to insist that EPA establish all of the necessary procedures, including oversight and approval of EPA-compliant OBD systems, to ensure manufacturers' ability to design and sell EPA-certified 49-state products. That potential result would have significant ramifications for those aspects of the California economy that rely on the availability of new HDOH engines and vehicles.

In addition, the increasingly likely result that manufacturers will pursue EPA's certification of 49-state products means that CARB's core assumption regarding the costs of its HD OBD program, including the pending amendments, no longer holds — that assumption being that "virtually all engine and vehicle manufacturers have chosen to design a single HD OBD system that meets both CARB and U.S. EPA regulations" and that "any increase in costs will also be experienced by non-California business" (2018, ISOR, p. 192). "Virtually all" manufacturers are not likely to continue to design 50-state products that meet CARB's increasingly onerous and prohibitively costly OBD (and other) requirements, but instead could pursue EPA's certification of 49-state products that comply with EPA's less onerous OBD requirements. A necessary consequence of that distinct possibility is that CARB needs to recalculate all of the projected costs of its HD OBD regulations using California-only volumes (34,735 vehicles (2018 ISOR, p. 194)), not nationwide sales volumes (500,000 units (2018 ISOR, p. 179)). Without recalculating those cost analyses in a manner that accounts for the potential consequences of the pending regulatory proposals, the rulemaking at issue will be inherently unreasonable. And, just as important, once CARB recalculates the costs of its HD OBD program using California-only sales volumes, the net cost-effectiveness calculation will be similarly unreasonable and violative of CARB's delegated authority.

Cost-Prohibitive Regulations Are Invalid

As detailed below, CARB's prescriptive-based HD OBD regulations are cost-prohibitive and are being amended to become even more so, especially when assessed in the appropriate context of California-only sales volumes. That is significant because "the Legislature has granted CARB authority to adopt regulations designed to reduce air pollution caused by motor vehicle emissions as expeditiously as possible, *subject to cost-effectiveness and feasibility limitations*." *Engine Mfrs. Assoc. v. State Air Resources Board*, 231 Cal. App.4th 1022, 1025(2014). (Emphasis added.) Accordingly, "because cost-effectiveness and feasibility limitations are built into the grant of authority [to CARB], if [OBD requirements] are 'unduly onerous and costly,' . . . the regulations may fall outside the scope of [CARB's] authority." Id. at 1041.

CARB's HD OBD regulations have reached the point where they are unduly onerous and costly, and exceed the bounds of CARB's regulatory authority. Consequently, the Board should not approve the proposed amendments, which will further increase the costs and burdens of CARB's HD OBD regulations, but instead should direct that CARB staff undertake a comprehensive and rigorous study of the cost-effectiveness of the entire HD OBD program as it has expanded to date, and report back on how that program can be revised and streamlined so that it can conform to the cost-effectiveness and feasibility limitations that bound CARB's authority, and so that it might accommodate and foster a paradigm shift to performance-based regulations.

The Preemption Waiver Process

The cost-prohibitive nature of CARB's pending HD OBD regulations — which renders them invalid as outside the scope of CARB's authority — also would disqualify them from obtaining a legitimate preemption waiver under the federal Clean Air Act (CAA). Under section 209(a) of the CAA, no state or any political subdivision thereof "shall adopt or attempt to enforce any standard relating to the control of emissions from new motor vehicles or new motor vehicle engines." 42 U.S.C. § 7543(a). However, the CAA provides a specific carve-out from preemption for California. More specifically, California may receive a preemption waiver from EPA for California standards relating to the control of emissions from new motor vehicles or new motor vehicle engines, if, among other things, the "standards and accompanying enforcement procedures are consistent with section 7521(a) [section 202(a)]" of the CAA. 42 U.S.C. § 7543(b)(1)(c). Under CAA section 202(a), emission standards applicable to new HD engines and vehicles must be "achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply, *giving appropriate considerations to cost*, energy and safety factors associated with the application of such technology." 42 U.S.C. §7 521(a)(3)(A). (Emphasis added.) Moreover, section 202(a) provides additional constraints on HD engine and vehicle regulations, as follows:

> Any standard promulgated or revised under this paragraph and applicable to classes or categories of heavy-duty vehicles or engines shall apply for a period of no less than 3 model years beginning no earlier than the model year commencing 4 years after such revised standards is promulgated.
> 42 U.S.C. § 7521(a)(3)(C).

As detailed below, CARB's HD OBD regulations have expanded to the point where they are cost-prohibitive and not achievable in a reasonable manner "giving appropriate considerations to cost." In addition, the proposed HD OBD amendments are violative of the CAA's 4-year leadtime requirement, since they will take effect in 2022, and in some instances starting as early as 2021. Both of those fundamental aspects of the pending HD OBD amendments violate section 202(a) of the CAA, and would preclude them from receiving a preemption waiver under CAA section 209(b). That, in turn, would render them void and unenforceable under federal law, just as they are beyond the scope of CARB's authority under California law.

Prior Preemption Waivers for
CARB's HD OBD Regulations

EPA has issued three previous preemption waivers for CARB's HD OBD regulations, covering CARB's initial adoption of its HD OBD program in 2005, and two subsequent series of amendments that CARB adopted in 2009 and 2013. (See 73 FR 52042, Sept. 8, 2008; 77 FR 73459, Dec. 10, 2012; and 81 FR 78149, Nov. 7, 2016). In none of those instances did EPA engage in any independent, rigorous or consistent analysis of whether CARB's HD OBD regulations "were achievable for the model year to which such standards apply, *giving appropriate consideration to cost*," as required under Sections 209(b)(1)(c) and 202(a)(3)(A) of the CAA. Instead, EPA simply relied on the representations regarding California-only in-state costs that CARB made to the Agency in CARB's formal preemption waiver requests. Those costs representations, however, were and are wrong — by orders of magnitude.

While EPA failed to conduct any independent nationwide cost analysis in granting the three preemption waivers for CARB's HD OBD regulations, the Agency did note in its Decision Document dated August 13, 2008, that the CAA "required the Administrator to decide whether the costs of developing and applying the [HD OBD] technology within the time [allocated] are feasible." (Decision Document, p.10.) EPA went on to note that it would "continue to closely monitor manufacturer progress in meeting the technical requirements of the OBD regulations, and CARB's efforts to address manufacturer-identified feasibility issues." (Id. at ll.) Similarly, in its 2016 preemption waiver decision, EPA reiterated that there can be instances where "the cost of compliance would be so excessive, such that California's [HD OBD] standards might be inconsistent with section 202(a)." (81 FR at 78154.) Both CARB and the regulated industry should be concerned that the costs of compliance with CARB's HD OBD regulations, and the pending amendments, have become so excessive that the amendments may not qualify for a preemption waiver, just as they no longer conform to the limits on CARB's authority under State law.

The CARB-Represented Costs
<u>of Its HD OBD Requirements</u>

CARB's representations, including to EPA, regarding the costs of CARB's HD OBD regulations are contained in the Initial Statement of Reasons ("ISOR") supporting CARB's adoption and subsequent amendments of the HD OBD regulations, and in CARB's preemption waiver applications to the Agency. The gist of those representations is as follows:

(i) In its ISOR dated June 3, 2005, relating to its initial adoption of HD OBD requirements, CARB stated that the full "learned-out costs per engine" for the HD OBD program would be $132.39. (2005 ISOR, p.121.)

(ii) In its ISOR dated April 10, 2009, relating to its adoption of the MST program, CARB stated that the per-manufacturer cost of the MST program would be $103,150, or just $1.97 per engine. (2009 ISOR, p. 88.) CARB repeated that per-engine cost of $1.97 in its preemption waiver application, dated September 27, 2010, relating to the MST program (Waiver Request Support Document, p.42.) In the current ISOR, CARB concedes that its 2009 amendments were premised on "an unintended undercounting of the costs for the MST program" (2018 ISOR, p. 186), but claims that the undercounting was, in effect, only by a factor of 13.7% (2018 ISOR, p. 187). That translates to a revised CARB-estimated per engine cost for the MST program of $2.23 ($1.97+0.26).

(iii) In its ISOR dated July 5, 2012, relating to various previous amendments to its HD OBD regulations, CARB stated that the incremental costs of the amendments would be less than $0.56 per vehicle, resulting in an aggregate per-vehicle cost of $134.92 ($132.39 + 1.97 (now $2.23) + 0.56). (2012 ISOR, p.55.) CARB reiterated those incremental and aggregate cost estimates to EPA in CARB's subsequent preemption waiver application, dated January 7, 2014. (Waiver Request Support Document, pp. 49-50.)

(iv) In the current ISOR for the pending HD OBD amendments, CARB estimates that the costs resulting from the new OBD requirements (including increased deficiency fines, and NO_x/fuel-consumption tracking and binning requirements) will total approximately $42.46 on a per-vehicle basis, resulting in a total aggregate cost for all aspects of CARB HD OBD program of $207.86 per vehicle/engine. (2018 ISOR, p. 8.)

(v) On the benefits side, CARB has estimated (and still estimates) that its HD OBD regulations will result in statewide cumulative lifetime emissions reductions on a per-engine basis of 165 pounds of VOC (ROG), 2000 pounds of NO_x, and *14 pounds of PM*. (2009 ISOR, p.86; 2018 ISOR, p. 172.) (Emphasis added.)

As explained below, CARB's cost estimates, including its latest estimates relating to the pending HD OBD amendments, are understated by more than an order of magnitude (and also fail to utilize the appropriate California-only sales volume of 34,735 vehicles), raising the very real prospect that CARB's HD OBD regulations exceed and violate CARB's authority under the Health and Safety Code, and CAA Sections 209(b) and 202(a)(3)(A), especially as the latter provision relates to the impacts of excessive costs on feasibility. Accordingly, the Board should not approve the proposed HD OBD amendments, but instead should direct CARB staff to conduct a thorough, comprehensive and cumulative assessment of the actual cost-effectiveness of CARB's HD OBD program (in the aggregate, not in piecemeal fashion), and to report back to the Board with recommendations on how the HD OBD program can be streamlined to the point where it is truly cost-effective and better aligned with a potential shift toward performance-based regulations.

The Actual Costs (And Projected Benefits)
Of CARB's HD OBD Regulations

In assessing the actual costs of CARB's HD OBD regulations, it is most straightforward (based on the cost data available to EMA) to assess the cost impacts on the five major manufacturers of heavy heavy-duty ("HHD") engines that comprise roughly 90% of the market for engines installed in large Class 7-8 commercial vehicles. An initial step in that process is to assess the volume of relevant HHD engine sales in California across which volume the costs of CARB's HD OBD regulations should be applied. Approximately 250,000 Class 7-8 vehicles are sold in the United States on an annual basis. If we assume that California accounts for 10% of the domestic Class 7-8 vehicle market, that corresponds to 25,000 Class 7-8 vehicle sales on an annual basis. Ninety percent of that number is 22,500. Dividing that number among the five major HHD engine manufacturers yields a per-manufacturer annual California sales number of 4,500 HHD engines. That is the number of vehicles against which the actual per-manufacturer costs of CARB's HD OBD regulations should be assessed.

EMA has conducted a cost survey of the leading manufacturers of HHD engines. The resultant cost data indicate the following:

(i) HHD engine manufacturers are spending on average approximately $10,550,000 per year to comply with CARB's HD OBD regulations, which translates to approximately $2,344 per engine ($10,550,000 ÷ 4,500), which is well more than an order of magnitude higher than CARB's revised per-engine cost estimate for its HD OBD regulations ($207.86).

(ii) HHD engine manufacturers are spending on average approximately $1,528,000 per year to comply with CARB's current HD OBD current MST program, which translates to approximately $340 per engine ($1,528,000 ÷ 4,500), which is well more than two orders of magnitude higher than CARB's updated per-engine cost estimate for its MST program ($2.23), and amounts to a total per engine HD OBD cost of $2,684 ($2,344 + $340). The proposed revisions to the MST program would reduce the average annual MST costs to approximately $1,000,000 or $222 per engine (down from $340).

(iii) HHD engine manufacturers estimate that the additional cost increases that will result from the pending HD OBD amendments will total approximately $4,265,910 per manufacturer (not including MST-related costs), which amounts to $2,448 per engine, primarily due to the new hardware and software costs for CARB's NO_x/fuel-consumption tracking and binning requirements, and the increased OBD deficiency fine structure, which CARB is proposing to increase by at least a factor of three (up to $1,500 per engine). That is, again, nearly two orders of magnitude greater than CARB's cost estimate of $42.46 per engine. EMA's cost survey demonstrates that CARB's cost analysis unreasonably underestimates the time/cost to design, develop, test, and implement the proposed HD OBD expansions, while also assuming that each manufacturer's current OBD-related systems and required changes are similar. (A copy of EMA's assessment of the costs of the pending HD OBD amendments compared against CARB's estimate (2018 ISOR, Appendix F) is attached as Exhibit "A", and EMA's more detailed white paper regarding one cost line item — "Readiness Work Package" — is attached as Exhibit "B".)

(iv) In terms of a relative cost-effectiveness metric — i.e., cost-effectiveness in dollars-per-ton of emissions reduced — CARB's HD OBD regulations are completely off the scale of any reasonable measure. More specifically, based on CARB's estimate of the statewide lifetime emissions benefits from the HD OBD regulations, the per-engine cumulative lifetime reduction of PM (the pollutant that drives most of the value of CARB's and EPA's calculations of monetized health benefits) is only 14 pounds. (2009 ISOR, p. 86; 2018 ISOR, p. 172.) If we assume that HHD engines have a 20-year lifetime, that would result in an average per-year PM reduction of 0.7 pounds. Taking the relevant annual California sales volume of HHD engines into account (22,500 HHD engines), that translates to 15,750 pounds or 7.9 tons of PM per year. If that aggregate annual PM reduction is compared against the estimated aggregate annual cost of the HD OBD program in California for the five major HHD engine manufacturers ($52,750,000 (5 x $10,550,000) + $7,640,000 (5 x $1,528,000) + $21,329,550 (5 x $4,265,910) = $81,719,550), the cost of CARB's HD OBD program is approximately *$10,344,247 per ton of PM*. That is a cost-effectiveness value that (again) exceeds any reasonable cost benchmark by multiple orders of magnitude. Even if that PM cost were divided in half to reflect CARB's unsupported assertion that one-half of all OBD costs are "for PM emission benefits" (2018 ISOR, p. 190), the per-ton-PM cost is still more than $5 million. To provide further perspective, EPA's cost-effectiveness projections for its last three significant HDOH engine PM standards were $17,000 per ton ("EPA's 2010 Standards"), $46,000 per ton ("EPA's Urban Bus Rule"), and $37,000 per ton ("EPA's 1998 Standards"), adjusted from 1999 to 2018 dollars using the U.S. Bureau of Labor Statistics' Consumer Price Index. (See 66 FR at 5102.)[2]

(v) While it is beyond the scope of these comments for EMA to conduct and present a full economic benefits analysis of CARB's HD OBD regulations, it is instructive to compare CARB's HD OBD regulations to EPA's 2010 HDOH engine emissions standards. EPA projected that the EPA-2010 standards would result in monetized net benefits of $66.2 billion. EPA calculated that result by subtracting its projected costs of $4.2 billion from its projected benefits of $70.4 billion, noting that at least 89 percent of those benefits resulted from projected PM reductions and the associated reduction of PM-related mortality and morbidity impacts. (See 66 FR at 5105 and 5107.) Conservatively, those benefits could be considered entirely PM-related, even though some of those benefits are related to projected ozone and other criteria pollutant reductions. The resultant EPA-2010 standards' benefit-to-cost ratio was 16.8-to-1 ($70.4 ÷ $4.2), which corresponds to the EPA-2010 PM cost-effectiveness of $17,000 per ton, noted above. Hypothetically, had EPA projected the EPA-2010 PM-related costs to be 16.8 times more expensive, i.e.,

[2] EMA's cost analysis, as noted, is just an initial step in assessing the aggregate cumulative costs of CARB's HD OBD regulations. A full cost assessment would need to include not only manufacturing costs (design, development, production, labor and materials, opportunity costs due to research facilities being repurposed for MST, and sales costs), but also all attendant socio-economic costs (including lost sales due to higher prices, higher freight-shipping costs due to more expensive trucks, potential job losses among shippers, truck dealers, manufacturers and other impacted employers, and all other down-stream impacts on the California and national economy).

$285,600 per ton, then the EPA-2010 PM standards would have had a "neutral", 1-to-1, benefit-to-cost ratio. Any PM cost-effectiveness projection greater than $285,600 per ton would have resulted in a net cost to the public, rather than a net benefit. By comparing CARB's HD OBD regulations' PM cost-effectiveness of $10,344,247 per ton to that threshold of $285,600 per ton, it is clear that the costs of CARB's HD OBD regulations vastly exceed (by well more than an order of magnitude) any plausible amount of projected benefits. Based on that analysis, CARB's HD OBD regulations have a benefit-to-cost ratio of 0.0276-to-1, or inversely, a cost-to-benefit ratio of 36.2-to-1. That is far beyond the bounds of any reasonable cost-benefit metric, and confirms that the HD OBD regulations are cost-prohibitive, and so invalid.

From the foregoing, it is clear that CARB has substantially underestimated the costs of its HD OBD regulations in its multiple ISORs and in its several submissions to EPA seeking preemption waivers, and that CARB continues to do so. It also is apparent that the actual cost-effectiveness and benefit-to-cost ratio of CARB's HD OBD regulations are so unreasonable "that California's standards [are] inconsistent with section 202(a)" of the CAA (81 FR at 78154), and exceed CARB's delegated authority. Accordingly, as noted above, the Board should not approve the pending HD OBD amendments, but rather should direct CARB staff to develop a detailed and cumulative assessment of the actual aggregate costs of CARB's HD OBD regulations using California sales volumes, and to report back on the manner in which CARB's HD OBD program can be streamlined to meet the operative requirements of cost-effectiveness and feasibility.

Other Core Issues Warranting Disapproval
<u>of the Pending HD OBD Amendments</u>

There are multiple other issues beyond the cost-prohibitive nature of CARB's prescriptive-based HD OBD program that warrant the Board's disapproval of the pending HD OBD amendments. Those issues include the lack of requisite leadtime, an unreasonable and disproportionate OBD deficiency fine structure, the inclusion of non-germane requirements to track and bin second-by-second and cumulative NO_x emissions and fuel-consumption data, and CARB's failure to conduct the mandated analyses under the California Environmental Quality Act (CEQA), including the required Standardized Regulatory Impact Assessment (SRIA).

The Proposed HD OBD Amendments
<u>Fail to Provide Requisite Leadtime</u>

The bulk of the proposed HD OBD amendments, including the new requirements for increased in-use monitor performance ratios (IUMPRs) and for HDOH engines to track and bin second-by-second and cumulative NO_x emissions and fuel-consumption (discussed in more detail below), will take effect starting at the beginning of 2022, which is only three full model years following the November Board hearing date on this matter, and just two full model years after any formal final rulemaking approval that would come after review by California's Office of Administrative Law (OAL). CARB's proposal for a three-fold increase in OBD deficiency fines would have even less leadtime, since those enhanced fines would phase-in starting in 2021.

In addition, engine manufacturers are required to submit their fully developed OBD system descriptions, test data, and specifications to CARB staff for review and approval 6-9 months in advance of engine production. As a result, the actual available leadtime for manufacturers to complete the necessary OBD design and testing work to develop the requisite OBD system information, following OAL approval of the regulatory changes at issue, is not two years, but slightly more than one year.

The leadtime that CARB has proposed to provide for the HD OBD amendments is inadequate and violates sections 209(b)(1)(c) and 202(a)(3)(c) of the federal CAA. CARB must, at a minimum, delay the effective dates for the proposed HD OBD amendments to provide four full model-years' leadtime. Accordingly, none of the proposed additive amendments to CARB's HD OBD regulations should take effect prior to the 2024 model year.

The Proposed Increase in OBD
Deficiency Fines is Inherently Unreasonable

As a component of the pending HD OBD amendments, CARB staff is proposing very significant three-fold increases in the fines associated with deficient OBD monitors. That proposed fine structure is excessively punitive when considered in the context of CARB's stated goal to reduce real-world emissions. The proposal appears to be a direct effort to force manufacturers to reduce or eliminate the initial deficiencies that all manufacturers need to utilize to try to make the overall OBD program feasible. The imposition of the proposed severe fine structure, coupled with the currently undefined (and somewhat subjective) expectations of OBD certification staff, and also with the additional 400-plus data-monitoring parameters, will require significant changes in manufacturers' production approval processes. It is vital that CARB maintain the current availability of deficiencies as a practical relief valve for the technical issues that manufacturers almost certainly will encounter during the implementation of the numerous proposed HD OBD amendments.

CARB staff's stated purpose for the "enhanced" deficiency fines is to deter manufacturers from "requesting deficiencies instead of putting in the effort and resources needed to produce a compliant OBD system, specifically with emission threshold monitors." (2018 ISOR, p. 137.) The more specific driving force behind the significantly increased fine structure is CARB's desire to dissuade manufacturers from using deficiencies as a mechanism to relieve potential additional MST burdens (that would occur three years after the initial certification of an engine family). (2018 ISOR, p. 138.) If that is so, then CARB's objective should be to make the deficiency fines, on a per-engine and annualized cost basis, just marginally higher than the projected cost of the additional MST testing that is associated with deficient OBD monitors (i.e., acquiring up to 9 more in-use engines and testing them at the manufacturer's facilities). CARB apparently used manufacturers' MST costs, as reported to CARB, to set the proposed increase in fines. However, and as explained in detail below, the proposed deficiency fines are vastly higher than the actual additional MST costs at issue.

Before assessing the degree to which CARB has over-priced the proposed deficiency fines, it is important to note the very real constraints that already preclude any purely strategic use of deficiencies. In that regard, CARB staff appear to be overlooking the many existing regulatory requirements that are directed at incentivizing compliant products. CARB does not issue deficiencies unless a manufacturer first demonstrates technological infeasibility after good faith efforts toward compliance. Further, most deficiencies must be rectified within two model years.

That said, a deficiency allowance for up to three years is often necessary to accommodate product-planning lifecycles and the time required to implement design/hardware changes.

New OBD technology can require multiple years of verification testing and development to implement, and such technology often is necessitated due to the "technology forcing" nature of CARB's onerous OBD requirements. Supplier selection and contract negotiation, production-line modifications, training, and service support all require lead-time. Increasing deficiency fines due to early-year issues in implementing new technology could discourage manufacturers from embracing new technology approaches due to increased financial risk. Moreover, current fines already create competitive disadvantages for non-compliant manufacturers. Thus, CARB's asserted rationale for the proposed dramatic increase in deficiency fines is overstated.

It also should be remembered that CARB's HD OBD program already is, by far, the most expensive HDOH certification regulation. HDOH engine manufacturers, on average, have spent $65 million to comply with CARB's regulations, and are, on average, facing continuing compliance costs of more than $15 million per year. As a result, the cost-per-ton-PM for the HD OBD program is several million dollars, demonstrating that the HD OBD program already is cost-prohibitive and unreasonable, even before enhanced deficiency fines are added on top.

EMA acknowledges that CARB has revised the scale of the increased deficiency fines from what CARB staff first presented in earlier workshop meetings. Nonetheless, the revised fine structure still increases unduly the cost-prohibitive and invalid nature of the HD OBD regulations, and is well in excess of the benchmark cost of the additional MST expenses that manufacturers theoretically might try to avoid through the use of OBD deficiencies. Similarly, the proposed $1,500 per-engine cap on deficiency fines (as of 2023) is still too high (and too soon), and would amount, in effect, to a $150 surcharge on every HDOH engine sold in the United States (assuming California represents 10% of the HDOH engine market). To put that in perspective, the de facto $150 nationwide per-engine surcharge that CARB is proposing exceeds CARB's original per-engine cost estimates for the *entire* HD OBD program, which CARB calculated (erroneously) in 2012 to be $134.92. (See ISOR, July 5, 2012, p.55.)

In assessing the requisite revisions to the proposed OBD deficiency fines, it is helpful to return to CARB's stated rationale for enhanced fines. Again, CARB's purported rationale is to deter manufacturers from making strategic (as opposed to technically required) requests for OBD deficiencies to avoid the potential costs of additional MST for non-compliant threshold monitors. Based on manufacturers' actual MST experience and projections, even under CARB's proposed amendments to the MST program, those additional MST costs would total approximately $1,000,000, not $363,717 as CARB has incorrectly estimated. (2018 ISOR, p. 187.) Thus, to be consistent with CARB's stated rationale, the maximum aggregate cost for any emission threshold deficiency(ies) over the potential three-year duration of the deficiency(ies) should be marginally in excess of $1,000,000 to deter the strategic use of deficiencies. CARB's proposal remains well in excess of that relevant benchmark.

A simple example bears this out. EMA member data indicate that, for the major HDOH engine manufacturers, HD OBD certification groups in California (which are not necessarily identical to engine families) average around 2,000 engines (not 250-1000 engines as CARB has asserted previously). Under CARB's proposed amendments, if a given OBD certification group had a single "ET2" deficiency that needed to be carried over for three years, the aggregate cost of that single deficiency would be $1,275 ($300 + $300 + $325 + $350) per engine, totaling $2,550,000 ($1,275 x 2,000) — which is nearly three-times (3x) more than the relevant benchmark. This new deficiency fine payment structure would also be unreasonably punitive considering new NOx emissions regulations envisioned by CARB that could drive new technology as it matures to fully comply with the HD OBD regulations. That is not consistent with CARB's stated rationale for enhanced deficiency fines, and could make it cost-prohibitive for many HDOH engine manufacturers to continue to do business in California.

The proposed $1,500 per-engine cap on deficiency fines does not alleviate this fundamental problem. To the contrary, that cap actually represents a three-times (3x) exceedance of the relevant benchmark. Again, if we assume that a representative OBD group in California amounts to 2,000 HDOH engines, the corresponding per-engine maximum fine to yield the $1,000,000 benchmark for an OBD ET deficiency would be $500. CARB's proposed $1,500 cap is 3-times that benchmark amount.

More fundamentally, there are other more targeted means for CARB to deter specific HDOH engine manufactures from trying to make strategic use of OBD deficiencies. As noted above, CARB has the ability to deny deficiencies that are not requested in good faith or that are not truly necessary. Similarly, CARB can withhold approvals of carry-over deficiencies or CARB can issue conditional certifications where appropriate. All of those more targeted approaches for deterring specific manufacturers' unwarranted strategic use of deficiencies are far more reasonable than imposing a cost-prohibitive fine structure on the entire HDOH industry.

There is another fundamental issue regarding CARB's current proposal that bears repeating. CARB's industry-wide enhanced fine structure would start to take effect in 2021, and would be in full force (with the $1,500 cap) by the 2023 model year. That is not consistent with the four-year leadtime and three-year stability-period requirements that CARB is obligated to provide under sections 209 and 202(a) of the federal CAA. CARB's current and pending HD OBD requirements are standards relating to the control of emissions, and deficiency fines relate to their enforcement. Accordingly, the CAA's preemption waiver provisions fully apply. CARB's current proposal is inconsistent with those provisions.

The bottom line is that CARB's current proposal for dramatically increased fines could threaten the viability of the California market for HDOH engines. CARB's proposal, therefore, is inherently unreasonable as it could engender fundamental alterations to HDOH engine manufacturers' ability to conduct business in California. It should be remembered that, as stated above, OBD deficiencies serve as necessary (and therefore utilized) safety valves that help to ensure the overall feasibility of CARB's technology-forcing OBD requirements. EPA specifically relied on the availability of deficiencies in its earlier preemption waiver for CARB's OBD requirements. CARB's proposed restrictions on the utility and availability of OBD deficiencies inherently undermines the overall feasibility and validity of the HD OBD program.

In light of the foregoing, if CARB still feels that some increase in the OBD deficiency fine structure is warranted, the revised fines should be implemented, as follows:

- No increases in fines should take effect without providing 4-years leadtime (i.e., until the 2024 model year) and should be phased-in over a 4-year time period to allow manufacturers time to fully implement CARB's augmented HD OBD requirements.
    - CARB's proposals to require more than 400 new OBD data elements, along with NO_x and fuel-consumption binning and tracking, creates multiple new technological hurdles, significant data-handling and storage challenges, and complex design issues, all of which will require adequate 4-years' leadtime to, among other things, adjust product development efforts and calendars.
- There should be no base fine multipliers for differing ET deficiencies; rather, relative increases in fines should be accounted for through the use of marginally higher carryover multipliers for higher ET deficiencies.
- Any increased cap on deficiencies (i.e., up to $1000 in 2027) should apply to all deficiencies, not just non-emission threshold deficiencies. Emission-threshold (ET) deficiencies already will have a carryover-multiplier applied.
- CARB staff are proposing to include non-germane elements into the HD OBD program, such as NO_x binning, fuel-consumption tracking, and NO_x sensor performance requirements; no deficiency fines should be assessed with respect to those non-germane requirements.
- Manufacturers should be able to receive a deficiency fine "rebate" for running changes that are promptly implemented into engines and vehicles in the field. If the deficiency fines are to be increased, manufacturers should receive some corresponding benefits from proactive mitigation actions.
    - One approach for calculating the rebate would be to tie the rebate percentage to the percentage of FUL that is remaining for an engine family at the time its OBD deficiency is remedied. The rebate could be limited to running changes and field fixes that are implemented in the first two years of a deficiency.
    - Software changes typically cannot be implemented in the first year, which is why a two-year window is needed.
- Fines for minor monitor deficiencies would increase from $25 to $50 per engine starting in 2024.
- Fines for major monitor deficiencies would increase from $50 to $100 per engine in 2024.
- The cap on <u>all</u> deficiency fines, including ET deficiencies, would be phased-in over a 4–year period, as follows:

    $600 in 2024
    $700 in 2025

$800 in 2026
$1000 in 2027

- This represents a phase-in of a 2-fold increase in deficiency fines, as opposed to CARB's 3-fold increase over an impermissibly short period of time.
- ET deficiencies should only be applied to emissions threshold diagnostics that are subject to emissions measurement/requirements in demonstration testing.
- At least one ET deficiency should be included in the two "free" deficiencies.
  - This allows appropriate flexibility for manufacturers who are trying, in good faith, to comply but may have something go awry during certification testing.

- As the HD OBD requirements get more and more onerous and cost-prohibitive, it is increasingly important that CARB staff implement and enforce those requirements (including through the allowance of deficiencies and the assessment of fines) in a fair and even-handed manner, using uniform definitions of the applicable requirements, to ensure a level regulatory playing field for all HDOH engine manufacturers. Thus, there will need to be some form of objective OBD review board to which manufacturers can appeal to ensure that CARB staff implement the augmented HD OBD requirements, including deficiency findings and resolutions thereof, in a fair and uniform manner, and pursuant to a well-defined process toward resolution.
- CARB cannot and should not enforce its enhanced HD OBD program and fine structure until it receives an updated preemption waiver from U.S. EPA.

The Proposed Non-Germane
Requirements for NO_x and Fuel Consumption
Binning and Tracking Should Be Deleted

CARB's proposed HD OBD amendments include new prescriptive-based requirements for recording second-by-second and cumulative NO_x emission and fuel-consumption data, and storing those data using a CARB-prescribed "binning" strategy. EMA has several significant concerns with the substance of that proposal, but also with the concept of including those types of emissions-binning provisions in the HD OBD regulations.

Pursuant to CCR Title 13 §1971.1(a), the purpose of the heavy-duty on-board diagnostics system requirements is:

> [T]o reduce motor vehicle and motor vehicle engine emissions by establishing emission standards and other requirements for onboard diagnostic systems (OBD systems) that are installed on 2010 and subsequent model-year engines certified for sale in heavy-duty applications in California. The OBD systems, through the use of an onboard computer(s), shall monitor emission systems in-use for the

> actual life of the engine and *shall be capable of detecting malfunctions of the monitored emission systems, illuminating a malfunction indicator light (MIL) to notify the vehicle operator of detected malfunctions, and storing fault codes identifying the detected malfunctions*. The use and operation of OBD systems will ensure reductions in in-use motor vehicle and motor vehicle engine emissions through improvements of emission system durability and performance. (Emphasis added.)

Nothing in the Legislature's specified purpose for CARB's HD OBD requirements involves the tracking, storage and binning of second-by-second emissions or fuel-consumption data. In fact, nothing in the underlying OBD regulations requires that tailpipe emission levels be monitored at all. Rather, the HD OBD regulations are directed at monitoring emission control systems upstream to detect malfunctions in the system's ability to control emissions. The proposed emissions-recording requirements would amount to a significant, unjustified and improper expansion of the scope of CARB's HD OBD regulations.

Even CARB concedes that its NO_x/fuel-consumption tracking and binning proposal is beyond the scope of legitimate OBD requirements and amounts, in effect, to a regulatorily-compelled manufacturer-funded emissions inventory research. In that regard, the ISOR states in relevant part as follows:

> Such data would . . . enhance the accuracy of CARB's emissions inventory. . . . Sorting the tracked data . . . 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. . . . CARB also anticipates using such data for . . . 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 California's GHG goals. (2018 ISOR, pp. 102, 103, and 114.)

It is clear, then, that the mandated measurement, recording and "binning" of real-time emission and fuel-consumption levels is substantially beyond the scope of the existing OBD regulations, including in terms of cost and complexity. Accordingly, the proposed substantial change in scope would more appropriately be considered a major new rulemaking action requiring a full cost-benefit and feasibility analysis, along with an independent review by EPA to determine whether the preemption waiver requirements can be met.

In addition to being out of scope and non-germane to the stated purpose of OBD regulations, the proposed requirements to record and bin real-time NO_x emissions raise a number of significant feasibility concerns. For example, CARB has failed to consider whether the proposed emissions-binning requirements would be feasible at the ultra-low NO_x standards that CARB is considering adopting for HDOH engines in 2019. Further, CARB has failed to assess in an adequate manner the feasibility and cost of the engine software and data-storage systems improvements that will be needed to manage, track, and bin the vast amount of second-by-second emissions data at issue (16 bins, 6 parameters, and 4 arrays), and to resort those data in 100-hour and cumulative increments. Similarly, CARB has not considered the feasibility and costs of the improvements that would need to be developed to enhance the processing speed and data-handling capabilities of current NO_x sensors. CARB also has failed to take into account that the NO_x-binning proposal, in addition to requiring the use of additional and substantially enhanced NO_x sensors, also could require the use of additional ammonia sensors to try to ensure the accurate recording of NO_x emissions, and not NO_x plus NH_3. All of those significant technical concerns support the conclusion that the proposed NO_x-binning requirements should not be considered as a simple "biennial" add-on to the current HDOBD regulations.

It also is premature to include prescriptive-based NO_x-tracking and "binning" requirements in the HD OBD program before all stakeholders, including EPA, have had the opportunity to determine how those types of second-by-second and cumulative emissions tracking requirements might be utilized in the next tier of low-NO_x regulations that are being discussed and developed for presentation to the Board in 2019. In that regard, it is especially important to ensure that any NO_x recording and "binning" requirements do not conflict with the next-tier NO_x regulations that CARB staff are developing, but have not yet formulated, and with those that EPA staff will be considering as well. Those considerations clearly indicate that CARB should wait until the next-tier low-NO_x requirements have been developed and articulated - - and until a potential paradigm shift to performance-based regulations has been fully assessed - - before proceeding to adopt any specific NO_x-recording and binning requirements. Again, the current biennial review process is simply not the right context for assessing and implementing those types of emissions-tracking capabilities and mandates.

Accordingly, EMA requests that CARB refrain from proceeding with the proposed major expansion of the scope of the current HDOBD regulations in the context of the current biennial review process. Real-time fuel-consumption and NO_x-tracking and "binning" requirements should be considered in the context of the development of next-tier new-paradigm low-NO_x regulations where those types of requirements will be most germane, and where their feasibility can be fully assessed.

If CARB insists on proceeding with some form of NO_x/fuel-consumption tracking and binning requirements, those requirements should be simplified. More specifically, given the complexity of the proposed NO_x/fuel-consumption binning and tracking arrays and the anticipated dramatic increase in the required NVRAM, EMA recommends that the "Active 100-hour" and "Stored 100-hour" arrays should be omitted, and that the requested data elements of "Positive Kinetic Energy" (PKE) and "Engine-out NO_x" also should be removed.

The Active 100-hour and Stored 100-hour arrays for NO_x/fuel-consumption binning and tracking are not necessary and add significantly to the cost of the requirements. Short-term vehicle emission studies can readily be performed by recording the data in the Lifetime and Engine activity arrays before any data collection begins, and subsequently by subtracting the previously recorded data when data collection ends to assess the short-term emissions behavior of vehicles. CARB's agreement that collection of the Active and Stored 100-hour arrays as part of the over-the-air update provisions are not necessary confirms that the Active 100-hour and Stored 100-hour arrays are not necessary data.

Industry's review of the relevant literature reveals that there are few formal, scientific papers discussing the use of PKE data for HD vehicles. Thus, CARB's inclusion of PKE amounts to a requirement that industry subsidize basic research into the driving habits of HD vehicle owners and drivers, all of whom already have an economic incentive to maximize fuel economy. At best, PKE data will yield data from two distinct modes of operation, loaded and unloaded, resulting in PKE stored values that represent neither mode of operation.

Engine-out NO_x emission tracking is clearly not related to any aspect of real-world emissions performance. Moreover, the requirements to determine the engine-out NO_x emissions accuracy would require modifications to the exhaust system to obtain a sample, along with a separate NO_x emission analyzer system in 1065 compliant test cells. As a result, the cost and complexities of all of the requirements related to measuring, tracking and binning engine-out NO_x would provide no environmental benefit and should be removed. EMA's suggested omissions and simplifications are highlighted in Exhibit D in the table cells containing red backgrounds.

The increased NVRAM requirements for NO_x/fuel-consumption binning and tracking is 2,384 bytes of new information to be stored across ignition key cycles. Accounting for the limitations of NVRAM (or flash memory) technology, a minimum of 20,480 bytes are needed. This represents a ten-fold increase over the existing CARB OBD required NVRAM allocation. See Exhibit E.

NVRAM technology does not provide infinite life in terms of the number of times a value can be written into an individual memory location. In fact, NVRAM technology exhibits an established wear-out phenomenon. As a result, data that is to be stored must have multiple memory locations provided in order to achieve the desired product-life goals. A "ring of eight" strategy can be employed to provide the multiple memory locations. In a "ring of eight" strategy, each data item is allocated eight memory locations in NVRAM. The data storage routine rotates the memory locations such that each of the eight locations is used equally, and is utilized for one-eighth of the storage events. The life estimate for the NVRAM locations is summed across the eight locations to provide the expected life for the ring of eight storage method. CARB staff has informed industry that intermediate sums in the NO_x/fuel-consumption binning and tracking are to be provided

HD manufacturers do not use battery-backed RAM because many heavy duty vehicle owners are known to disconnect the vehicle's batteries, causing the data to be lost if battery-backed RAM is selected to store data across key cycles. Also, battery-backed RAM can be disturbed by the voltage drop that is experienced when the starter motor is engaged on a diesel engine. Indeed, a reset of an ECM during engine start is a known phenomenon.

Accordingly, for the reasons detailed above, if CARB proceeds with NO_x/fuel-consumption tracking and binning, those requirements will need to be simplified as EMA recommends. See Exhibit D.

Other Aspects of the Proposed
HD OBD Amendments Warrant Revision

There are several other specific aspects of the proposed HD OBD amendments that need revision, including the proposals for:

- Increased IUMPR Requirements
- REAL (Real Emissions Assessment Logging)
- Software Design Documentation
- Environmental and Cost Impact Analysis

IUMPR: CARB staff have asserted that there are no indications that manufacturers will have difficulty meeting the proposed 0.300 minimum in-use monitor performance ratio (IUMPR), which refers to the number of times a monitor should run during each CARB-defined drive cycle. A ratio of 0.300 means that an OBD monitor should run 3 times out of every 10 drive cycles. The current IUMPR is 0.100, so CARB is proposing a 300% increase in stringency.

CARB staff have concluded that every manufacturer should be capable of increasing all monitors to comply with the proposed 0.300 minimum requirement. (2018 ISOR, pp. 3, 27-30.) However, staff's analysis is fundamentally flawed, since it assumes that each monitor and its related IUMPR are isolated from interaction with other monitors and the overall OBD system calibration. When manufacturers calibrate their OBD control systems and develop the resulting IUMPR for each monitor, there is a significant interaction between the various monitors and the rest of the OBD system. Increasing the IUMPR of one monitor to the minimum 0.300 criteria may significantly impair the ability of another monitor to achieve the desired 0.300 minimum requirement. CARB staff's comparison of HD diesel OBD systems and the related IUMPRs with light-duty gasoline OBD systems highlights staff's lack of understanding of the complexity of HD diesel systems. (Id.) Given the complexity of the HD diesel control systems and the development time required to achieve the proposed 0.300 minimum IUMPR levels, it is imperative that additional lead-time be provided. More specifically, since the monitors that will require development are system-dependent, EMA recommends that two free deficiencies be provided until 2024 for the IUMPR calibration changes required to achieve the proposed 0.300 minimum criteria.

REAL: The concept of collecting emission data from a larger population of vehicles over the wide range of real-world operating conditions may warrant consideration in the future. However, as proposed by CARB staff, the data to be collected is disproportionally large and burdensome in comparison to the stated potential use of the information. Staff have proposed that manufacturers collect multiple bins of data to be stored in current, cumulative 100-hour, and lifetime arrays, but there is nothing included in the proposal regarding CARB's access to or use of the collected and binned data. EMA members have proposed reducing the data collection by eliminating the engine-out NO_x, and limiting the collected information to the lifetime array only, recognizing that there are only two logical scenarios where CARB would access the data: (i) if at some point in the future CARB developed a program requiring that the collected data be reviewed as part of a compliance evaluation; or (ii) if CARB wanted to evaluate a given in-use vehicle over a specific test route. See Exhibit D. In either of these cases, the lifetime data would provide CARB staff all the relevant information by either downloading the vehicle history or by comparing the vehicle history before and after testing on the specified route. For manufacturers to be required to track and store engine-out NO_x, and current and cumulative 100-hour data requires significant resources in terms of programing and data storage.

In addition, CARB staff have proposed that all of the available data be captured and reported to CARB if/whenever an over-the-air reprogramming event takes place. The amount of data to be captured and reported is significantly greater if it must include real-time and 100-hour data in addition to the lifetime data. Moreover, the current proposal has not included any provisions for CARB staff to access the data, for CARB to store the data, or for CARB staff to analyze the data. As such, the proposed current and cumulative 100 hour data requirements are unwarranted and unjustified, and should be deleted. In addition, there are a significant number of other technical details associated with the REAL data requirements, as spelled out in the technical comments table included below.

Software Design Documentation: As acknowledged in the ISOR, engine manufacturers have significant concerns associated with the requirement that they provide CARB staff with manufacturers' engine control unit (ECU) software design specifications and source codes. Staff assert that this information will only be requested where detailed information is needed for staff to evaluate emission control diagnostics or pre-certification screening. However, manufacturers believe that given the significant complexity of the emission control and OBD systems required to comply with CARB emission standards, those criteria could be applicable to every OBD approval application. Additionally, given the complexity of the systems, it is highly likely that CARB staff's receipt of the requested proprietary materials will result in numerous additional questions regarding the executable logic contained within the information submitted. EMA recommends that CARB staff's authority to request this highly proprietary information be expressly limited to those specific circumstances that might justify the request, such as when an enforcement action is being considered by the CARB. CARB staff have indicated that a special workspace and more restrictive staff-access provisions would be in place to ensure that manufacturers' highly proprietary information would not be divulged, which implies that the number of such requests would be substantially more limited than the proposed regulatory language indicates. EMA's recommendation to limit CARB staff's requests for highly proprietary information in an explicit manner is more in-line with CARB's stated intent.

Environmental and Cost Impacts: CARB staff's assertion that the proposed HD OBD amendments will not have an adverse environmental impact is incorrect. Analyses of the impact of costs on new engine/vehicle purchasing decisions are well documented and clearly evident in the case of heavy-duty engines, as historically demonstrated by "pre-buy" marketplace activities when regulations have increased either purchase costs or costs of operations. In addition, a current analysis already shows that California lags significantly behind other states in the purchase and deployment of new heavy-duty engines. Additional California-only regulations that increase the costs for CARB-certified engines will exacerbate that trend, resulting in fewer new engines being introduced, and older engines remaining longer in the California marketplace. CARB's inventory modeling assumptions regarding engine replacement and resulting environmental benefits significantly distort the perceived environmental benefit of CARB's emission regulations. Consequently, as discussed further below, the proposed amendments, in combination with the additional HDOH regulations that CARB is developing, significantly increase the potential for substantially reduced new engine offerings in California, and significantly increase the prospects for resulting adverse air quality ramifications.

CARB staff's estimated cost impact of $42.46 per-engine for the revised HD OBD regulations, and the related cost estimate of $207.86 per-engine for the combined HD OBD and enforcement regulations are significantly understated. Utilizing the same type of cost matrix that CARB staff included as Appendix F to the current ISOR, EMA members have determined that the actual cost for the current HD OBD program is $2,684 per engine, and that actual per-engine cost for the proposed HD OBD amendments will be an additional $2,448. Given that more accurate cost assessment, and as expanded on in other sections of EMA's comments, it is clear that the proposed HD OBD amendments cannot be considered cost-effective under any reasonable criteria or metric.

EMA's More Specific Technical Comments

In addition to the foregoing substantive comments regarding the overly-burdensome and invalid nature of the proposed HD OBD amendments, EMA has a number of specific technical comments relating to several of the specific pending regulatory proposals, which are summarized in the following table:

Section Number	CARB's Proposed Regulatory Language	EMA's Comments and Concerns
1971.1(c) Definitions	"Active technology" refers to a system, device, or distinct operational mode that reduces carbon dioxide emissions or fuel consumption when activated, and is either controlled by the engine or required to be monitored by the OBD system in accordance with section 1971.1. Some examples of this technology include active technologies that improve the aerodynamic profile of the vehicle (e.g., adjustable grille shutters, retractable gap fairings), intelligent control technologies that, when activated, control a vehicle in such a way as to obtain maximum fuel efficiency (e.g., predictive cruise control, neutral coast), vehicle speed limiter, cylinder deactivation, and driver-selectable hybrid modes (e.g., eco mode, sport mode, mountain mode).	Engine manufacturers' can only provide data on active technologies that they directly control. Engine manufacturers cannot be expected to canvass vehicle manufacturers 3 years in advance to plan for the monitoring of "active technology" features provided by the vehicle manufacturer without using the engine control module. The example of retractable fairings is clearly a function where the engine will be unaware of the active control status. Vehicle manufacturers should not be precluded from buying a particular brand of engine because they were unable to disclose their active technology plan to the engine manufacturer three years in advance. EMA welcomes the change to the definition of active technology to only include technologies controlled by the engine or required to be monitored by the OBD system. EMA requests that the examples provided be updated to reflect the definitional change to eliminate possible confusion on the subsequent requirements.
1971.1(d)(2.1.2)	The MIL shall illuminate in the key-on, engine-off position before engine cranking to indicate that the MIL is functional. For all 2022 and subsequent model year vehicles containing a non-analog MIL (e.g., liquid-crystal display (LCD)), any delay in MIL illumination prior to the functional check may not exceed 5 seconds. The MIL shall continuously illuminate during this functional check for a minimum of 15 seconds. During this functional check of the MIL, the data stream value for MIL status shall indicate commanded-off (see section (h)(4.2)) unless the MIL has also been commanded on for a detected malfunction. This functional check of the MIL is not required during vehicle operation in the key-on, engine-off position subsequent to the initial engine cranking of an ignition cycle (e.g., due to an engine stall or other non-commanded engine shutoff).	This provision should be rephrased as follows: For all 2022 and subsequent model year engines, the display of the MIL's functional check by any vehicle shall not be delayed by more than 5 seconds due to any limitation of the MIL's display technology. [e.g., The adverse impact of cold temperatures on liquid crystal displays must be managed to make the bulb check visible under expected operating temperatures.]
1971.1(d)(2.2.1)(D) (vi)& (vii)	(vi) 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 fault code that is currently not commanding the MIL on, the freeze frame conditions shall be replaced with freeze frame conditions for the pending fault code. (vi) 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	Engines that provide more than one freeze frame already account for the issue addressed under (D)(iv) by voluntarily providing additional freeze frame data. Requiring such engines to change their freeze frame management methods where multiple faults are already stored has little real benefit and is unduly burdensome.

	a confirmed fault code that is currently not commanding the MIL on, the freeze frame conditions shall be replaced with freeze frame conditions for the pending fault code.	
1971.1 (d)(2.3.2)(C)	(1) no sooner than the end of the driving cycle in which the identified malfunction has not been again detected in at least 40 consecutive warm-up cycles and the MIL has not been illuminated for that malfunction for at least 40 consecutive warmup cycles, and (2) no later than the end of the driving cycle in which no malfunction has been detected in 41 consecutive warm-up cycles and the MIL has not been illuminated for any malfunction for 41 consecutive warm-up cycles.	Taking longer to clear a code is not a relaxation of the regulation. The current regulation does not include the criteria of the MIL not being on for other malfunctions. The new regulation requires consecutive cycles without MIL for any malfunction. It does not make sense to tie code-clearing for one monitor to all other codes.
1971.1(d)(3.1.3)	…. Additionally, for 2022 and subsequent model year engines, the manufacturer may request to define monitoring conditions designed to ensure monitoring will occur during the SET cycle only for monitors for which the in-use monitor performance is tracked and reported as required under section (d)(3.2.1).	The proposed language prevents monitors that are not part of IUMPR tracking and reporting from using RMCSET as a detection cycle. CARB Staff is assuming that if the RMCSET is used as the detection cycle then by default those monitors will have poor IUMPR in the real world. So, if a monitor that is not tracked and reported uses RMCSET for detection, then its IUMPR is not captured, resulting in poor IUMPR. However, this assumption is not true. There are cases where the RMCSET detection cycle and the real world IUMPR provide good results. Accordingly, EMA requests that language be added stating that if manufacturers can show good IUMPR performance, they can use the RMCSET for monitors that are not part of IUMPR tracking and reporting. This proposed language also conflicts with the demonstration testing protocol language in (i)(5.1.1) and (i)(4.2.2) that allows the MIL to be illuminated by the end of the emissions test and that allows the emissions test to be an RMCSET if it is the worst case cycle. Therefore, the proposed language added to (d)(3.1.3) must be revised to ensure that monitors that meet CARB's other regulatory requirements that are demonstrated on the RMCSET test cycle as the worst case are not automatically required to be tracked and reported as required under section (d)(3.2.1).
1971.1(d)(3.1.4)	Additionally, for 2022 and subsequent model year engines, the manufacturer may request to define monitoring conditions designed to ensure monitoring will occur during the SET cycle only for monitors for which the in-use monitor performance is tracked and reported as required under section (d)(3.2.1).	Manufacturers should have the option to provide evidence of on-road operation from development data.

1971.1(d)(3.1.4)	For intrusive diagnostics, the manufacturers shall submit a monitoring strategy plan to the Executive Officer for review and approval. The Executive Officer shall approve the plan if the manufacturer has submitted data and/or engineering evaluation demonstrating any of the following: (A) Running the intrusive diagnostic will not affect the effectiveness of the emission control system during any reasonable in-use driving conditions. (B) If running the intrusive diagnostic reduces the effectiveness of the emission control system during any reasonable in-use driving conditions, the intrusive diagnostic runs only once after the MIL is illuminated for the fault by a non-intrusive diagnostic. (C) If running the intrusive 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 driving conditions, the manufacturer shall meet the following requirements: (i) If the manufacturer determines that emissions using the standard test procedures are not representative of real world driving, the manufacturer must submit a plan to the Executive Officer for approval of the use of alternate test procedures. Executive Officer approval of these alternate test procedures shall be based on the determination that the alternate test procedures would result in test cycle emissions representative of in-use driving conditions. If the Executive Officer determines that emissions on the standard test cycles are not representative of real world driving, the Executive Officer may direct the manufacturer to use alternate test procedures.	The definition and prohibitions relating to “intrusive diagnostics” are too broad and will effectively prevent the use of well-established and effective diagnostic practices. Prohibition of intrusive diagnostics that “reduce the effectiveness of the emission control system during any reasonable in-use driving conditions” also will prohibit intrusive diagnostics where the on-road emissions impact is inherently captured during emission testing. Examples of monitors that would be prohibited include monitors that intrusively take over fueling reactivation after decel fuel-cuts, monitors that intrusively move turbo or EGR actuators to check for lack of response during common FTP conditions, and hybrid electric vehicle monitors that intrusively delay a fueled engine pull-down until an OBD monitor completes. This also could result in the elimination or substantial reduction in effectiveness for a number of comprehensive component rationality monitors due to the intrusive monitor prohibition overriding the requirement to monitor to “the extent feasible” at the same time as when their minimum IUMPR ration is being increased. The proposed regulatory text should be revised to allow for: • Intrusive monitors that are substantially included in regulated emissions test cycles. • Intrusive monitors with no measurable impact on emissions (similar to criteria used for comprehensive component “can affect emissions during any reasonable in-use driving condition”).
1971.1(d)(4.3.2)(G)(i)	(i) Diesel NMHC converting catalyst (section (e)(5.2.2)) on 2010 through 2021 model year engines	Some manufacturers do not rely on regeneration to run the DOC NMHC monitor. Those manufacturers cannot use a regen-based denominator and will lose the ability to use an 800 minute denominator starting 2022.
1971.1 (d)(6.2.3)	For calculating the adjustment factors in section (d)(6.2), the manufacturer shall submit a frequency factor derivation plan to the Executive Officer for approval. The Executive Officer shall approve the plan upon determining the frequency factor derivation appropriately incorporates the impact of the malfunction on the regeneration event frequency.	This requirement adds significantly to the documentation work required and should be eliminated.
1971.1 (e)(1.3.3)	Manufacturers shall track and report the in-use performance of the fuel system monitors under sections (e)(1.2.2) and (e)(1.2.3) in accordance with section (d)(3.2.1).	These monitors are already required to meet minimum ratio requirements. However, the additional tracking and reporting defined here requires software changes. Additional lead time will be required to develop the required software.

1971.1(e)(9.2.2)(E)	NOx sensor activity faults: For 2022 and subsequent model year engines, the OBD system shall detect a malfunction of the NOx sensor when the NOx sensor is not actively reporting NOx concentration data (i.e., the NOx sensor is not “active”) under conditions when it is technically feasible for a properly-working NOx sensor to be actively reporting NOx concentration data. If the NOx sensor activity fault is caused by a malfunction of a component other than the NOx sensor (e.g., a component that is used as an input necessary to make the NOx sensor become “active”), the OBD system shall monitor the component and detect a malfunction that prevents the NOx sensor from being “active”.	This is a new diagnostic that requires significant development work. The proposed lead time is not sufficient to develop and implement this new diagnostic.
1971.1 (e)(10.1)	Requirement: The OBD system shall monitor the VVT system on engines so-equipped for target error and slow response malfunctions. Manufacturers must perform a comprehensive failure modes and effects analysis for every reasonable hydraulic or mechanical failure (e.g., partial or complete blockage of hydraulic passages, broken return springs, a failure of a single cylinder-specific pin to move into the desired position on a lift mechanism) to identify target error and slow response malfunctions.	The “failure modes and effects analysis” (FEMA) needs to be removed. EMA recommends that the text read: “Manufacturers must perform a comprehensive analysis of every reasonable…”
1971.1(g)(1.1.4)	For vehicles with engine cooling systems that include components modulated by a control unit (e.g., electrical water pump, electrically heated thermostat) to regulate the ECT, the manufacturer shall submit a monitoring plan to the Executive Officer for approval. The Executive Officer shall approve the plan upon determining that the manufacturer has submitted data and an engineering evaluation that demonstrate that the monitoring plan is as reliable and effective as the monitoring requirements specified for the thermostat under section (g)(1).	The revised language uses "modulated by control unit," which still has the ambiguity regarding what constitutes a "control unit." If an electric pump just turns on/off based on coolant temp, one could interpret that as not being modulated by a control unit. Additional lead-time is required for this requirement (2022 or later) as well.
1971.1(g) (2.2.3)(A) Crankcase Ventilation (CV) System Monitoring Also 1968.2(d)4.3(M)	…the OBD system shall detect a malfunction of the CV system when a disconnection of the system occurs between the crankcase and the CV valve, or between the CV valve and intake ducting. For any hose, tube, or line that transports crankcase vapors, the OBD system shall detect a CV system malfunction when the system contains a disconnection or break equal to or greater than the smallest internal cross-sectional area of that hose, tube, or line. For the purposes of section (g)(2.2.3), “hose, tube, or line” includes any fittings that are used for connection such as nipples or barbs that the hoses must be placed over for proper attachment.	Boosted spark-ignition engines will be required to monitor the lines between the crankcase and fresh air intake. This can only be done under boost conditions. EMA requests that monitoring of lines between the crankcase and fresh air intake for boosted spark-ignition engines be subject to denominator requirements similar to those for the OBD II denominator for high load purge in 1968.2(d)(4.3)(M) (i.e. manifold pressure > 7 kPa above atmosphere on two or more occasions for two or more seconds on a drive cycle). We also request that 1968.2(d)(4.3)(M) be updated to allow for the use of this denominator for crankcase ventilation monitoring requirements of lines between the crankcase and fresh air intake required to be monitored under 1968.2(e)(9.2.3).

1971.1 (g)(3.2.1)	Except as provided in sections (g)(3.1.3), (g)(3.1.4), (g)(3.1.5), (g)(3.1.6), and (g)(4), the OBD system shall monitor for malfunction any electronic powertrain component/system not otherwise described in sections (e)(1) through (g)(2) that either provides input to (directly or indirectly) or receives commands from ~~the~~ an on-board computer~~(s)~~ or smart device, and any of the following: (1) can affect emissions during any reasonable in-use driving condition, or (2) is used as part of the diagnostic strategy for any other monitored system or component, (3) is used as an input to (directly or indirectly) an inducement strategy on 2022 and subsequent model year engines, or (4) is used as an input to (directly or indirectly) or output from an AECD strategy…..	EMA requests that the proposed regulation be clarified to specify criteria emissions to avoid confusion between criteria and GHG emissions as follows: …..(1) can affect NOx, NMHC, CO or PM emissions during any reasonable in-use driving condition,…..
1971.1 (g)(3.2.2)(D)	Except as provided for below, the wait-to-start lamp circuit shall be monitored for malfunctions that cause the lamp to fail to illuminate when commanded on (e.g., burned out bulb). The manufacturer is exempt from monitoring the wait-to-start lamp if any of the following criteria are met: (i) For wait-to-start lamps located on the instrument cluster on an LCD screen, a malfunction that causes the wait-to-start lamp to black out also causes the vehicle speed, engine speed, and fuel level displays to black out; or (ii) The engine is prohibited from cranking until the glow plugs have been activated for a manufacturer-determined amount of time necessary for optimum cold start performance and emission control.	EMA requests that CARB include the following proposed language in LD/MD 1968.2 Regulations in diesel CCM section (f)(15.2.2)(D). Except as provided for below, the wait-to-start lamp circuit shall be monitored for malfunctions that cause the lamp to fail to illuminate when commanded on (e.g., burned out bulb). The manufacturer is exempt from monitoring the wait-to-start lamp if any of the following criteria are met: (i) For wait-to-start lamps located on the instrument cluster on an LCD screen, a malfunction that causes the wait-to-start lamp to black out also causes the vehicle speed, engine speed, and fuel level displays to black out; or (ii) The engine is prohibited from cranking until the glow plugs have been activated for a manufacturer- determined amount of time necessary for optimum cold start performance and emission control.

1971.1 (g)(5.7)	The manufacturer may request to exempt a specific component from all monitoring requirements if all malfunctions of the component affect emissions or the diagnostic strategy for any other monitored component or system only when the ambient temperature is below 20 degrees Fahrenheit (or -6.7 degrees Celsius). The Executive Officer shall approve the request upon the manufacturer submittal of data or engineering evaluation supporting that ~~The OBD system is not required to monitor an electronic powertrain component/system~~ if the following criteria are met when the ambient temperature is above 20 degrees Fahrenheit (or -6.7 degrees Celsius): (1) a malfunction of the component does not affect emissions during any reasonable driving condition, (2) a malfunction of the component does not affect the diagnostic strategy for any other monitored component or system, and (3) the ambient temperature is determined based on a temperature sensor monitored by the OBD system (e.g., IAT sensor). ~~The manufacturer shall determine whether a component/system meets these criteria.~~ If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system meets these criteria, the Executive Officer shall require the manufacturer to provide emission and/or other diagnostic data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an effect on emissions or other diagnostic strategies. The Executive Officer may request emission data for any reasonable driving condition at ambient temperatures above 20 degrees Fahrenheit (or -6.7 degrees Celsius).	EMA requests that the requirements be aligned with 1968.2 (e)(17.7) - (e)(17.8) and (f)(17.8) - (f)(17.9) [note that language in sections (e) and (f) is identical] (e)(17.7) The manufacturer may request to exempt a specific component from all monitoring requirements if all malfunctions of the component affect emissions or the diagnostic strategy for any other monitored component or system only when the ambient temperature is below 20 degrees Fahrenheit. The Executive Officer shall approve the request upon the manufacturer submittal of data or engineering evaluation supporting that the following criteria are met when the ambient temperature is above 20 degrees Fahrenheit (or -6.7 degrees Celsius): (1) a malfunction of the component does not affect emissions during any reasonable driving condition, (2) a malfunction of the component does not affect the diagnostic strategy for any other monitored component or system, and (3) the ambient temperature is determined based on a temperature sensor monitored by the OBD ~~II~~ system (e.g., IAT sensor). If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system meets these criteria, the Executive Officer shall require the manufacturer to provide emission and/or other diagnostic data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an effect on emissions or other diagnostic strategies. The Executive Officer may request emission data for any reasonable driving condition at ambient temperatures above 20 degrees Fahrenheit (or -6.7 degrees Celsius). (e)(17.8) The manufacturer may request to exempt a specific component from all monitoring requirements if all malfunctions of the component affect emissions or the diagnostic strategy for any other monitored component or system only when the vehicle speed is above 82 miles-per-hour. The Executive Officer shall approve the request upon the manufacturer submittal of data or engineering evaluation supporting that the following criteria are met when the vehicle speed is below 82 miles-per-hour: (1) a malfunction of the component does not affect emissions during any reasonable driving condition, (2) a malfunction of the component does not affect the diagnostic strategy for any other monitored component or system, and (3) the vehicle speed is determined based on a sensor monitored by the OBD ~~II~~ system (e.g., vehicle speed sensor). If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system meets these criteria, the Executive Officer shall require the manufacturer to provide emission and/or other diagnostic data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an effect on emissions or other diagnostic

		strategies.
1971.1(h)(1.7)	SAE J1939 consisting of: (1.7.1) J1939 Recommended Practice for a Serial Control and Communications Heavy Duty Vehicle Network – Top Level Document, April 2011August 2013; (A) J1939-DA "Digital Annex of Serial Control and Communication Heavy Duty Vehicle Network Data," February 2018; (1.7.2) J1939/1 On-Highway Equipment Control and Communication Network May 2011November 2012; (1.7.3) J1939/11 Physical Layer, 250K Kbpsbits/s, Twisted Shielded Pair, September 2006December 2016; (1.7.4) J1939/13 Off-Board Diagnostic Connector, October 20112016; (1.7.5) J1939/15 Reduced Physical Layer, 250K Kbps bits/sec, UnN-Shielded Twisted Pair (UTP), August 20082015; (1.7.6) J1939/21 Data Link Layer, December 2010March 2016; (1.7.7) J1939/31 Network Layer, May 2010April 2014; (1.7.8) J1939/71 Vehicle Application Layer (Through May 2010), March 2011October 2016; (1.7.9) J1939/73 Application Layer—Diagnostics, February 2010May 2017; (1.7.10) J1939/81 Network Management, June 2011March 2017; and (1.7.11) J1939/84 OBD Communications Compliance Test Cases for Heavy Duty Components and Vehicles, December 2010October 2017.	The SAE J1939DA and SAE J1979DA versions cited do not provide the new content that is proposed in draft section (h). The large number of requests [over 450 new individual data items] will create a much longer than commonplace request queue for committee work. This will be difficult for industry's standards-development volunteer work force to complete, and adds risk to the 2022 engine MY requirements.

1971.1 (h)(2.2.1)(A)	For vehicles with a steering wheel and not equipped with a driver's side door, the connector shall be located in the driver's side foot-well region of the vehicle interior in the area bound by the driver's side of the vehicle and the driver's side edge of the center console (or the vehicle centerline if the vehicle does not have a center console) and at a location no higher than the bottom of the steering wheel when in the lowest adjustable position.	The content in (A) is not fully consistent with the content in 2.2 and 2.3. Are vehicles that comply with the addition in 2.3 fully compliant … or does both 2.2.(A) and 2.3 apply to all vehicles without driver's side doors? The driver's side edge of a center console is where the accelerator pedal is located and, as result, is not a practical location because no cables should be in proximity of the accelerator pedal. As specified in (h)(2.2.3) manufacturers are required to place the connector in a manner to ensure safe vehicle operation. For vehicles without a driver's side door, mounting the connector on the opposite side of the center line from the accelerator pedal provides a safe accessible location for connection of a scan tool. The insistence on the left side of the console or the vehicle centerline as the limit for vehicles with no driver's side door is an arbitrary choice, especially with respect to a technician who will be on the opposite side of the vehicle centerline from the accelerator pedal when he is looking for the diagnostic connector, and especially when his sightline may be obstructed by the center console. The sight line for a crouched technician is illustrated in Exhibit F. Additional content that is not prefaced with an effective date, and the regulation of autonomous vehicles is a substantive change. Vehicle dash panels and center consoles are highly tooled. New location content means that vehicle manufacturers will be required to modify dash panel and/or center console tooling by engine manufacturers to comply with the regulation.
1971.1(h)(2.3)	The location of the connector shall be capable of being easily identified and accessed (e.g., to connect an off-board tool). Except for as allowed in section (h)(2.2.1)(A) and (B), For vehicles equipped with a driver's side door, the connector shall be capable of being easily identified and accessed by a technician standing (or "crouched") on the ground outside the driver's side of the vehicle with the driver's side door open. For vehicles not equipped with a driver's side door, the connector shall be capable of being easily identified and accessed by a crouched technician.	See comment for (h)(2.2.1)(A). Locations visible to the technician viewing the interior of a vehicle with no driver's side door may not meet the limits imposed in (h)(2.2.1)(A), but would still provide acceptable, if not preferred, alternatives to locations left of the steering wheel.
1971.1(h)(4.2.3)	For all engines so equipped: (A) Absolute throttle position, relative throttle position, fuel control system status (e.g., open loop, closed loop), fuel trim <u>(short term, long term, secondary),</u> fuel pressure, ignition timing advance, fuel injection timing, intake air/manifold temperature, engine intercooler temperature,……	Industry notes that only two categories of fuel trim, are defined in SAE J1939DA, and two categories are believed to support all fuel trim communication needs today. It is expected that any party needing to define a third category will inform the SAE Committee with the new need.

1971.1(h)(4.2.3)F	(F) For 2022 and subsequent model year engines, commanded DEF dosing, DEF dosing mode (A, B, C, etc.), DEF dosing rate, DEF usage for current driving cycle, target ammonia storage level on SCR, modeled actual ammonia storage level on SCR, SCR intake temperature, SCR outlet temperature, NOx mass emission rate - engine out, NOx mass emission rate – tailpipe, stability of NOx sensor reading, EGR mass flow rate, engine fuel rate, vehicle fuel rate, hydrocarbon doser flow rate, hydrocarbon doser injector duty cycle, aftertreatment fuel pressure, charge air cooler outlet temperature, engine operating state, propulsion system active, odometer reading, hybrid/EV charging state, hybrid/EV battery system voltage, hybrid/EV battery system current, commanded/target fresh air flow, crankcase pressure sensor output, crankcase oil separator rotational speed, evaporative system purge pressure sensor output, and vehicle speed limiter speed limit.	The odometer reading is the vehicle manufacturer's responsibility and cannot be required of an engine, for engine dynamometer certified products. The engine ECM typically provides a vehicle distance display which is highly correlated to the odometer, but cannot be guaranteed to match the odometer display in the vehicle. This display is utilized by engine manufacturers to assess warranty claims data where the value of the odometer (the commonplace data for administering warranty claims) is in dispute. Displays of vehicle mileage by engine ECUs are not guaranteed to exactly match the odometer provided by the vehicle manufacturer. Industry believes that existing displays of total vehicle distance by engine and vehicle components will provide suitable data for CARB's needs and requests that the language be changed from odometer reading to total vehicle distance. The current methods between engine manufacturers and vehicle manufacturers are founded on prior negotiations regarding the level of responsibility that engine manufacturers are willing to assume on behalf of the vehicle manufacturer the odometer. An example legal policy disclaiming responsibility for the odometer by an engine manufacturer has been previously provided as confidential business information. Reversal of such a settled matter between engine manufacturers and vehicle manufacturers is not recommended.
1971.1(h)(4.2.2)(B)	Except as otherwise specified in sections (e) through (g), The stored fault code shall, to the fullest extent possible, pinpoint the likely cause of the malfunction. To the extent feasible, manufacturers shall use separate fault codes for every diagnostic where the diagnostic and repair procedure or likely cause of the failure is different. 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).	The manufacturer should have some say regarding the coordination of their service system and their products diagnosis and repair. "To the fullest extent possible" can be interpreted to mean that non-repairable components (e.g. resistors and capacitors in individual PWB circuits) need to be individually diagnosed. That may not be the example that CARB has in mind, but it does illustrate that the language in the phrase is overly broad. The language for circuit faults in (g) has specified the performance criteria distinctly for electrical circuit diagnostics, eliminating the need for the overly broad language. The requirement in (B) should reflect the content in (g).
1971.1(h)(4.7.6)	For purposes of Inspection and Maintenance (I/M) testing, manufacturers shall make the CVN and CAL ID combination information available for all vehicles in a standardized electronic format that allows for off-board verification that the CVN is valid and appropriate for a specific vehicle and CAL ID. The manufacturer shall use the most recent standardized electronic format is detailed in Attachment F of ARB Mail-Out #MSC 09-22, July 7,	EMA requests that section (h)(4.7.6) be removed entirely from 1971.1. Similarly, section (g)(4.7.5) of 1968.2 should also be deleted. At the 2018 US SAE OBD Symposium, it was discovered that the CVN and CAL ID data that is submitted by manufacturers is not used by ARB. California Bureau of Automotive Repair (BAR) reported that it currently gets CVN and CAL ID

	2009, incorporated by reference. Manufacturers shall submit the CVN and CAL ID information to the Executive Officer not more than 25 30 calendar days after the close of a calendar quarter. Manufacturers are required to submit information about all CVN and CAL ID combinations applicable for every vehicle, including CVN and CAL ID combinations from field fixes after the production period has ended.	information for SmogCheck directly from the manufacturers and not from the data submitted to ARB. Generating the CVN and CAL ID reports for ARB is a burden on manufacturers. Eliminating this requirement will eliminate this burden without having any impact on ARB or BAR's ability to do their work.
1971.1(h)(4.8.1)	All vehicles shall have the vehicle identification number (VIN) available in a standardized format through the standardized data link connector in accordance with SAE J1979/J1939 specifications. Only one electronic control unit per vehicle shall report the VIN to an SAE J1978/J1939 scan tool.	Refer to comments in (l)(1.1) and (l)(1.3) regarding the VIN and the definition for "Diagnostic of emission critical control unit
1971.1 (h)(4.8.2)	All 2013 and subsequent model year engines (except for heavy-duty engines certified to the Low Emission Vehicle III exhaust emission standards defined in title 13, CCR section 1961.2) shall have the engine serial number (ESN) available in a standardized format through the standardized data link connector. Only one electronic control unit per vehicle shall report the ESN to an SAE J1978/J1939 scan tool.	The vehicle manufacturer should be responsible for the display of the ESN on incomplete or complete chasses. Display of the ESN alone does not meet the criteria of a "Diagnostic or emission critical control unit" control module in (C). Industry believes that SAE J1939-84 should better reflect this text to accept an OEM-provided ESN.
1971.1 (h)(4.10.1)	For purposes of section (h)(4.10), "emission-related diagnostic information" includes at least all the following: (A) Readiness status (section (h)(4.1)) (B) Data stream information (section (h)(4.2)) including number of stored confirmed/MIL-on fault codes, distance traveled (or engine run time for engines not utilizing vehicle speed information) while MIL activated, number of warm-up cycles since fault memory last cleared, and distance traveled (or engine run time for engines not utilizing vehicle speed information) since fault memory last cleared, MIL status, and monitor status.	Industry believes this provision would be better phrased to say … includes all the following: There should not be a presumption that industry is responsible for omissions that are not listed. The addition of "At least" implies that the list may not be complete. CARB should provide a complete list for industry to use.
1971.1 (h)(5.2.1)(A,B,C)	For all gasoline and diesel engines, manufacturers shall implement software algorithms to individually track and report in a standardized format the engine run time while being operated in the following conditions: (A) Total engine run time; (B) Total idle run time (with "idle" defined as accelerator pedal released by driver, engine speed greater than or equal to 50 to 150 rpm below the normal warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission), PTO not active, and either vehicle speed less than or equal to one mile per hour or engine speed less than or equal to 200 rpm above normal warmed-up idle), and;	(A), (B), and (C) are scaled with a range that extends to no less than 133 years at 1 second per bit, or no less than 400 years at 3 minutes per bit (0.05 hours / bit). Reuse of existing SAE J1939DA SPNs saves industry implementation costs. Duplication of these values into SPNs that can be divided by two adds little if any value, and is inherently unreasonable.

	(C) Total run time with PTO active;	
1971.1(h)(5.2.2)(A)	Numerical Value Specifications: For each counter specified in section (h)(5.2.1): (A) Each number shall conform to the standardized format specified in SAE J1979/J1939.	The existing SAE J1939 engine-hour meter display (believed to be identified in (h)(5.1.1) is used to convey engine run time to the vehicle owner on the vehicle's instrument cluster. The divide by 2 proposition makes the engine-hour meter for (5.2.1)(A) unusable for emissions warranty administration and distorts its value as an indication of the use of the vehicle with respect to its useful life. It also makes existing engine-hour meter calculations unsuitable for reuse in NO_x Binning and Fuel-Consumption Tracking counters for engine run time. Storing a duplicate hour-meter to comply with the divide by two requirement is overly burdensome as it presents disparate requirements for the same hour meter. The other two counters for Idle Time and PTO time raise the same issue. Accordingly, the requirements of (5.2.2)(C) should apply only to (5.2.1)(D).
1971.1(h)(5.3.2)	(A) Active 100 Hour Array. (i) When the NOx sensors used to determine the NOx mass parameters listed in section (h)(5.3.1) are both reporting valid NOx concentration data, data for all parameters in section (h)(5.3.1) shall be stored in the Active 100 Hour Array. (ii) When the total engine run time value that is stored in Bin 1 (defined in section (h)(5.3.3)(A) below) of the Active 100 Hour Array reaches 100 hours, all stored data shall be transferred to the Stored 100 Hour Array described in section (h)(5.3.2)(B). All data in the Active 100 Hour Array shall be reset to zero and begin incrementing anew.	(5.2.3)(A) and (B) are not necessary. Short-term emissions performance studies can record the lifetime array values at the start of the study, and then can subtract those values at the end of the study. Eliminating those arrays would save about 30 percent of the NVRAM resources estimated for the NOx Binning requirements. Microcontroller NVRAM must be shared with other uses including fuel-consumption Tracking, Fault Codes, Test Results, Label Data, and Programmable parameters that adapt the engine to its application. Using this data to study 10 and 20-minute vehicle and engine dynamometer tests would require rescaling the data to accommodate 4 bytes, in order to have any hope of displaying a change in NOx Tons that would need to be scaled in micrograms. Scaling 100 hour data into 4 bytes adds about 30 percent to the NVRam memory requirements, and is not believed to be feasible. Industry communication committee members proposed two byte scaling in February of 2018 for SAE J1939DA and developed notational scaling based on dimensional analysis. Industry communication committee members believe that CARB staff concurs with that assessment, based on recent CARB staff discussions SAE MVC and T&B Communication committee members.
1971.1(h)(5.3.3)(D)	(D) Lifetime Engine Activity Array. (i) The parameters in section (h)(5.3.1)(C) through (F) are stored in the Lifetime Engine Activity Array whenever the engine is running regardless of NOx sensor status. (ii) The Lifetime Engine Activity Array maintains a running total of parameter data for the actual life of the engine.	Data in the Lifetime engine activity array duplicate data in the run-time tracking and fuel-consumption tracking requirements. (5.2.1)(E) duplicates (5.2.1)(A). (5.3.1)(D) and (F) duplicate (5.4.5) and (5.4.10). Those duplications have been noted in prior discussions with CARB staff, and those duplications should be eliminated. These values should be calculated only once.

1971.1 (h)(5.3.4)	(5.3.4) The engine-out and tailpipe NOx mass parameters that are calculated by the OBD system to fulfill the requirements in section (h)(5.3) and data stream requirements in section (h)(4.2) must not have an error of more than 20 percent, or alternatively 0.10 g/bhp-hr when divided by the net brake work of the engine. This requirement applies only to the NOx mass parameters in sections (h)(5.3) and (h)(4.2). Manufacturers shall report the most accurate values that are calculated within the applicable electronic control unit (e.g., the engine control module).	The tests needed to demonstrate the accuracy requirements in an accumulation of data add to industry's test burden. Checking accuracy increases utilization of scarce Part 1065-compliant emissions test cells at a time when CARB is demanding increased utilization for manufacturer self-tests and monitor demonstrations. Comparing the tolerance stack-up against the accuracy requirement, the available design margin after the stack-up is believed to be 2 percent or less or 0.01 g/bhp-hr based on industry discussions between SAE, MVC, and T&BC Communication Committee Members and CARB Staff. Such a slim design margin suggests that a manufacturer can in good faith calculate tailpipe NOx based on the formula and methods disclosed during the Nov. 2018 workshop and subsequent staff presentations to the public, and still have CARB Staff claim the manufacturer did not meet the accuracy requirement resulting in a deficiency
1971.1(h)(5.4.9)	Positive kinetic energy (PKE).	Literature searches for PKE and heavy-duty vehicles reveal that there are few studies from which to interpret data that manufacturers are being required to collect. CARB's own studies in support of the biennial review omitted PKE as a data collection objective when reported to the HD OBD Symposium, which indicates that PKE data have low value-added compared to the expense. Additionally, the PKE data for HD vehicles exhibit a bimodal or multi-modal distribution, because of the disparate power-to-weight ratios of HD vehicles created under laden and unladen conditions. The resulting metric would represent a weighted average of the disparate modalities that would not reflect the more common operating conditions of the HD vehicles from which it was collected. As such, PKE should be more thoroughly studied in HD vehicles before industry expends funds that will not directly improve air quality or improve OBD monitor performance.
1971.1(h)(5.4.17-22)	(5.4.17) Active technology #1 run time; (5.4.18) Active technology #2 run time; and so on up to (5.4.19) Active technology #n run time; (5.4.20) Distance traveled while active technology #1 is active; (5.4.21) Distance traveled while active technology #2 is active; and so on up to (5.4.22) Distance traveled while active technology #n is active.	See comments from section (c) regarding the definition for active technologies and the relationship between engine manufacturers and vehicle manufacturers. Active technologies are expected to be limited to those that the engine control module directly controls, and do not include content not provided by the engine manufacturer.
1971.1(h)(5.7)	For each parameter specified in sections (h)(5.4), (h)(5.5), and (h)(5.6):	The fuel-consumption Tracking Active and Stored 100 hour arrays are not necessary. As noted above, short-term emissions performance studies can record the fuel-

	(5.7.1) Each value shall conform to the standardized format specified in SAE J1939 or SAE J1979. (5.7.2) Except as provided below, each parameter shall be stored in three categories: (A) The active 100 hour category represents the most current up to 100 hours of operation. All values stored in this category shall reset to zero and begin incrementing anew when the engine run time in this category reaches 100 hours. (B) The stored 100 hour category represents values transferred from the active 100 hour category when the engine run time in the active category reaches 100 hours. The parameter specified under section (h)(5.4.10) is not required to meet section (h)(5.7.2)(B).	consumption tracking lifetime array values at the start of the study and can then subtract those values at the end of the study. Eliminating those arrays would save about 40 percent of the NVRAM resources estimated for the fuel-consumption tracking requirements. Microcontroller NVRAM must be shared with other uses including NOx binning, Fault Codes, Test Results, Label Data, and Programmable parameters that adapt the engine to its application. Together the NOx Binning and Fuel-Consumption Tracking arrays as proposed are estimated to require over 20 thousand bytes of NVRAM storage. It is not certain that there are sufficient available ECU and data-storage resources to support those requirement.
1971.1(h)(5.8)	For all 2022 and subsequent model year diesel engines, manufacturers shall implement software algorithms to track and report in a standardized format the following parameters: (5.8.1) <u>Distance since the last 3 PM filter regeneration events</u>; and (5.8.2) Lifetime counter of PM filter regeneration events. (5.8.3) Each number in section (h)(5.8) shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event). Numbers may not be reset to zero under any other circumstances including when a scan tool (generic or enhanced) command to clear fault codes or reset KAM is received.	The distance since the last 3 PM filter regeneration events is ambiguous and not reflective of staff's discussion with industry at the 2017 OBD symposium. This requirement is understood by industry as referring to the total vehicle distance reading during the last 3 regeneration events, and is not a dynamic quantity that would be expected to change as the vehicle is driven. For HD vehicles the SAE Committee recommendation will be that that the data should reflect the engines own total vehicle distance display and not the vehicle manufacturer's legal odometer.
1971.1(h)(6.2) Data Reporting Requirements for Over-the-Air Reprogramming: /From June 13, 2018/	6.2) The manufacturer shall submit a report to the Executive Officer containing the average value and standard deviation of each collected parameter for each affected certified engine family as specified in, "Data Record Reporting Procedures for Over-the-Air Reprogrammed Vehicles and Engines", dated August 16, 2018, and hereby incorporated by reference. The manufacturer shall submit the report within 60 calendar days of the availability of the calibration/software update to affected engines. The manufacturer shall submit a separate report for each unique calibration/software update.	Previous comments have discussed the data collection of the NOx Binning and Fuel-Consumption Tracking data. This data collection requires manufacturers to create an information system infrastructure and include computer software to calculate the required statistics. This goes beyond the "typical" cost structure of an HD OBD engine. Engine manufacturers believe that it is unlikely that data collected over 60 days will capture the majority of fleet vehicles. As a result, the average statistics of the calibration's early adopters may be biased compared to the fleet as a whole.
1971.1(i)(4) - ~~(4.2.3) ???~~ (4.3.2 (C)	Emission test data: For 2010 through 2021 model year engines, the emission test data shall include NMHC, CO, NOx, and PM emission data as applicable (based on the applicable emission threshold malfunction criteria). For all 2022 and subsequent model year engines, the emission test data shall include NMHC, CO, NOx, and PM emission data as applicable (based on	EMA proposes that only raw measured CO2 be included (no carbon or fuel-corrected values to be submitted). This requirement should not be held to the GHG Phase 2 standard of reporting.

	the applicable emission threshold malfunction criteria), and CO2 emission data for all monitors.	
1971.1(i)(4.1.1)(C)	(C) The manufacturer may not run a manual PM filter regeneration event immediately before or any time after the malfunction is implanted, except for the following: (i) When conducting the regeneration emission test under section (i)(4.2.3), (ii) If allowed under section (i)(4.2.1)(C)) for a monitor that requires a regeneration event to enable monitoring, or (iii) If a regeneration event is expected to occur during demonstration testing of a specific monitor under section (i)(4.1.2), (4.1.3), (4.2.1), or (4.2.2), the manufacturer may request Executive Officer approval to run a manual PM filter regeneration event before the malfunction is implanted for that specific monitor. Executive Officer approval shall be based on the manufacturer submitting data and/or engineering evaluation demonstrating that a regeneration event will most likely to occur during demonstration testing of the monitor (e.g., based on soot model information). If the Executive Officer approves the manual regeneration event, the manufacturer shall manually trigger a PM filter regeneration event while operating the engine on an FTP cycle and before the implanting the malfunction.	Language is needed to allow for manufacturer's discretion to execute regeneration to maintain the health of the aftertreatment throughout testing as needed. Manufacturers should be able to use standard stationary regeneration procedures to expedite testing. CARB's proposed language will unduly delay testing completion.
1971.1(i)(4.2.2)	Malfunction detection cycle: After the manufacturer has met the Preconditioning requirements under section (i)(4.1): (A) For monitors designed to run on the FTP cycle as described under section (d)(3.1.1)	EMA request that clarification be added regarding the preconditioning requirements in Section 1971 vs Part 1065.
1971.1(i)(4.3.3)	For 2022 and subsequent model year diesel engines, the manufacturer shall collect the following data stream values at 1 second intervals (i.e., 1 Hertz) and submit the data in a comma separated values file: engine speed, actual engine torque, reference engine maximum torque, engine coolant temperature, engine oil temperature, fuel rate, modeled exhaust flow, intake air/manifold temperature, air flow rate (from mass air flow sensor), fuel injection timing, EGR mass flow rate, commanded EGR valve duty cycle/position, actual EGR valve duty cycle/position, EGR error between actual and commanded, boost pressure, commanded/target boost pressure, PM filter inlet temperature, PM filter outlet temperature, exhaust gas temperature sensor output, variable geometry turbo position, corrected NOx	Some channels may not be available from every manufacturer. The requirement must be limited to available parameters. Modeled actual ammonia storage level on SCR, and target ammonia storage level on SCR present manufacturer proprietary information, which may be shared (if equipped) as part of (i)(4.3.3), but should be excluded from section (h). In section (h), DEF dosing rate should suffice to identify the operating goals of the engine. Modeled actual ammonia storage level on SCR, and target ammonia storage levels are not believed to be necessary for diagnosis and repair of SCR-related components.

	sensor output, DEF dosing mode, stability of NOx sensor reading, engine friction – percent torque, commanded DEF dosing, DEF usage for current driving cycle, DEF dosing rate, charge air cooler outlet temperature, SCR intake temperature, SCR outlet temperature, modeled actual ammonia storage level on SCR, and target ammonia storage level on SCR. These data shall be collected during any baseline testing and during demonstration testing of the NOx converting catalyst during the exhaust emission test cycle under section (i)(4.2.2)	
1971.1(i)(5.1.2)(A)	If the MIL illuminates prior to emissions exceeding the applicable emission threshold malfunction criteria specified in section (e) through (g) and a default fuel or emission control strategy is used when a malfunction is detected, the test engine shall be retested with the system or component adjusted to the worst acceptable limit (i.e., the applicable monitor indicates the system or component's performance is passing but at the closest possible value relative to the monitor threshold value at which a fault would be detected that would invoke the default strategy and illuminate the MIL). The manufacturer may request the Executive Officer to accept test data when the system or component's performance is at the worst acceptable limit within a margin of error necessary to accommodate testing variability and/or other practical limitations in setting the performance at the absolute worst acceptable limit. The Executive Officer shall accept the test data upon determining that the test data adequately demonstrate that emissions do not exceed the applicable malfunction criteria at the tested worst acceptable limit and that emissions will not exceed the applicable emission threshold malfunction criteria before performance exceeds the monitor threshold for fault detection.	The new proposed language uses the term "worst acceptable limit" which EMA thinks is too easily confused with the existing term "worst performing acceptable" which means something different. EMA suggests replacing "worst acceptable limit" with the term "BPU minus." In addition, EMA requests that a provision be added to this section allowing for Executive Officer approval for alternate techniques of demonstrating that emissions do not exceed the applicable emissions threshold at the "BPU minus" setting. For example, EMA member companies have previously demonstrated that emissions are acceptable at the BPU without the default fuel or emission control strategy by modifying the ECU calibration to disable the default fuel or emission control strategy that is used when the malfunction is detected.
1971.1(j)(2.16)	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),	Manufacturers already submit documentation for each running change. Adding all of this information in the next model year annual certification application is redundant work. At a minimum, CARB should clarify the process to allow for the submission of copies of prior running change documents.
1971.1(j)(2.22)	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.	Need definition of CSERS so that any new strategies in the future can be evaluated.

1971.1(j)(2.23)	For 2022 and subsequent model year diesel engines, data demonstrating the net brake torque reported by the engine dynamometer and the "calculated net brake torque" during the FTP and SET cycles.	Language needs to specifically call out baseline testing only (adopt language from (i)).
1971.1(j)(2.25)	For 2022 and subsequent model year diesel engines, 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, etc.) for each NOx sensor during the FTP cycle and the SET cycle. The data shall also 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).	Language needs to specifically call out baseline testing only (adopt language from (i)).
1971.1(j)(2.26) first	For 2022 and subsequent model year diesel engines, 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 (h)(5.3)) during one hot-start FTP emissions test.	Language needs to specifically call out baseline testing only (adopt language from (i)).
1971.1(j)(~~2.30)-~~ ~~(2.33~~) (2.32-2.33) renumbered due to correction of triplicate 2.26	For 2022 and subsequent model year engines in vehicles equipped with active technologies, a written description of each technology utilized by the manufacturer including the identification of each technology relative to the data required to be tracked and reported in the standardized format specified in sections (h)(5.4.17) through (h)(5.4.22) (e.g., Active Technology #1 is "haptic-feedback accelerator pedal"), the sensor signals and/or calculated values used to activate each technology (e.g., the tip-in rate of accelerator pedal is greater than a certain value), and the driver action (if any) required to activate the technology (e.g., driver tipped out within 1 second of feedback). (2.33) For 2022 and subsequent model year engines in vehicles equipped with automatic engine shutdown technologies, stop-start technologies, and waste heat recovery technologies, a written description of the technology, the sensor signals and/or calculated values used to activate the technology (e.g., the temperature of the engine exhaust is greater than a certain value), and the driver action (if any) required to activate the technology (e.g., driver pushes a button).	CARB must update examples to exclude vehicle side tracking as update to definitions per change to (h) engine only.
1971.1(l)(1.1) and (l)(1.3)	Requirement: Manufacturers shall perform testing to verify that 2013 and subsequent model year production engines installed in vehicles meet the	It is the manufacturers' expectation that the freeze frame update changes in 1971.1(d)(2.2.1)(D)(vi) & (vii) will not be included in SAE J1699-3 or SAE J1939-

	requirements of section (h)(3) and (h)(4) relevant to proper communication of required emission-related messages to an SAE J1978/J1939 scan tool. Test Equipment: For the testing required in section (l)(1), manufacturers shall utilize an off-board device to conduct the testing. Prior to conducting testing, manufacturers are required to request and receive Executive Officer approval of the off-board device that the manufacturer will use to perform the testing. Reference changes in 1971.1 (d)(2.2.1)(D)(vi)& (vii) and text in (h)(4.8.1).	84 test procedures. The number of faults that would need to be implanted to verify the required change exceeds the number of manipulations of a customer's vehicle that can be explained to the customer as a manufacturing quality check and would therefore diminish the commercial value of the vehicle as a new vehicle after it is tested. Engine manufacturers believe that the vehicle manufacturer is responsible for the display of the VIN on incomplete chasses and complete chasses sold by the vehicle manufacturer. Display of the VIN alone does not meet the criteria of a "Diagnostic or emission critical control unit" control module in (C). Industry believes that SAE J1939-84 should better reflect the text in (h)(4.8.1) to accept an OEM provided VIN.
1971.1(m)(1.1.7)	Copies of all service manuals, technical service bulletins and instructions regarding the use, repair, adjustment, maintenance, or testing of such vehicles relevant to the emission control system, OBD system, as applicable, issued by the manufacturer (in written or electronic form) for use by other manufacturers, assembly plants, distributors, dealers, and ultimate purchasers. These shall be submitted to the Executive Officer when they are made available to the public and must be updated as appropriate throughout the useful life of the corresponding vehicles.	The materials listed should only be required to be submitted with a running change or field fix if they are substantively changed. Most running change or field fix submissions do not result in changes to the vast majority of the information listed.
1971.1(m)(2.1)	The manufacturer may not submit to the Executive Officer a running change/field fix document for an engine family within 30 calendar days of the issue date of the OBD system approval date for the engine family.	CARB should be willing to allow early fixes to ensure production robustness, and, at a minimum, should add the language "unless previously approved by the EO" to the end of this provision.
1971.5 (b)(4)(A)(ii)-(v) ARB Enf. Test. – equipment to be provided by mfr. to support ARB testing. P.8	(ii) Complete software design description documentation, specifications, and source code of the engine control unit and any other on-board electronic powertrain control unit (e.g., transmission control unit, aftertreatment system control unit). The manufacturer shall provide the descriptions and specifications in English. (iii) A complete list and description of all control unit variables available for real-time display and data logging, as well as all calibration maps, curves, and constants used in the software. (iv) A data acquisition device with real-time display and data logging capability of any and all control unit variables used in calibration. These variables shall be provided in the same engineering units used during calibration (e.g., the units as documented in the AECD documentation provided to the Executive Officer). The data acquisition device shall	There must be explicit protections regarding the CBI nature of the information at issue, and the regulations should state clearly that the highly proprietary CBI would only be requested if there was a specific need for the information (e.g., a potential enforcement action).

	include, but may not be limited to, an engineering and calibration tool used during control unit software development and calibration. (v) A method to unlock any production or prototype control unit to allow real-time display and data logging of any and all variables used during calibration.	
1971.5(c)(2)(C)(iv) (a,b) P. 18 Vehicle mileage	(iii) Upon request of the manufacturer, the Executive Officer may approve an alternate engine selection criterion in lieu of a criterion described in sections (c)(2)(A) and (c)(2)(C)(i) above. a. The manufacturer may request Executive Officer approval to procure an engine that has mileage that is below 70 percent of the certified full useful life mileage in lieu of the criterion in section (c)(2)(C)(i)c. above. The Executive Officer shall approve the use of the engine upon determining that the manufacturer-submitted plan demonstrates that the engine will produce equivalent results to an engine with mileage that is between 70 to 100 percent of the certified full useful life mileage. The plan may involve the manufacturer operating the engine to accumulate more mileage on the engine, requesting a extension in the deadline set forth in section (c)(3)(A) below to allow for more mileage accumulation on the engine, and/or providing data showing operating hours-to-mileage equivalency.	CARB needs to confirm the common understanding that "providing data showing operating hours to mileage equivalency" means that the manufacturer can age the engine on the dyno following accepted practices for aging an engine for certification demo testing.
1971.5(c)(4)(A) (i,ii) P. 21 Additional Testing	(i) For deficient emission threshold monitors, either of the following thresholds, 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). (ii) For all other component/system monitors not mentioned in section (c)(4)(A)(i) above, the malfunction criteria defined in Cal. Code Regs., title 13, sections 1971.1(e) through (g).	The 20% variation allowance for NOx is acceptable, but for PM it results in a very small number that is not acceptable. 20% of the OBD threshold should be the margin.
1971.5(d)(3)(A)(i)	For major monitors required to meet the in-use performance ratio pursuant to Cal. Code Regs., title 13, section 1971.1(d)(3.2) and subject to the nonconformance criteria of section (b)(6)(B)(ii), (b)(6)(B)(iii), or (b)(6)(B)(iv) on 2016 and subsequent model year engines, the average in-use monitor performance ratio for one or more of the major monitors in the test sample group is less than or equal to 33.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) (e.g., if the required ratio is 0.100, less than or equal to a ratio of 0.033) or 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than or equal to 33.0	EMA's proposed text is as follows: Except as provided in sections (d)(3)(B) below, the Executive Officer shall order the recall and repair of all engines in an engine class that have been determined to be equipped with a nonconforming system if enforcement testing conducted pursuant to sections (b) or (c) above or information received from the manufacturer indicates that: (i) For major monitors required to meet the in-use performance ratio pursuant to Cal. Code Regs., title 13, section 1971.1(d)(3.2) and subject to the nonconformance criteria of section (b)(6)(B)(ii), (b)(6)(B)(iii), or (b)(6)(B)(iv)

	percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) for the same major monitor.	a. On 2016 through 2021 and on 2026 and subsequent model year engines, the average in-use monitor performance ratio for one or more of the major monitors in the test sample group is less than or equal to 33.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) (e.g., if the required ratio is 0.100, less than or equal to a ratio of 0.033) or 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than or equal to 33.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) for the same major monitor. b. On 2022 through 2025 model year engines, the average in-use monitor performance ratio for one or more of the major monitors in the test sample group is less than or equal to 20.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) (e.g., if the required ratio is 0.300, less than or equal to a ratio of 0.060) or 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than or equal to 20.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) for the same major monitor.
	(3) *Ordered Remedial Action-Mandatory Recall*. (A) Except as provided in sections (d)(3)(B) below, the Executive Officer shall order the recall and repair of all engines in an engine class that have been determined to be equipped with a nonconforming system if enforcement testing conducted pursuant to sections (b) or (c) above or information received from the manufacturer indicates that: (i) For major monitors required to meet the in-use performance ratio pursuant to Cal. Code Regs., title 13, section 1971.1(d)(3.2) and subject to the nonconformance criteria of section (b)(6)(B)(ii), <u>(b)(6)(B)(iii), or (b)(6)(B)(iv)</u> on 2016 and subsequent model year engines, the average in-use monitor performance ratio for one or more of the major monitors in the test sample group is less than or equal to 33.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) (e.g., if the required ratio is 0.100, less than or equal to a ratio of 0.033) or 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than or equal to 33.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) for the same major monitor.	EMA recommends that the regulatory language be revised as follows to allow for a more appropriate phase-in of the new IUMPRs and thresholds: (3) *Ordered Remedial Action-Mandatory Recall*. (A) Except as provided in sections (d)(3)(B) below, the Executive Officer shall order the recall and repair of all engines in an engine class that have been determined to be equipped with a nonconforming system if enforcement testing conducted pursuant to sections (b) or (c) above or information received from the manufacturer indicates that: (i) For major monitors required to meet the in-use performance ratio pursuant to Cal. Code Regs., title 13, section 1971.1(d)(3.2) and subject to the nonconformance criteria of section (b)(6)(B)(ii), <u>(b)(6)(B)(iii), or (b)(6)(B)(iv)</u> (a) With respect to 2016 through 2021 model year engines, and on 2026 and subsequent model year engines, the average in-use monitor performance ratio for one or more of the major monitors in the test sample group is less than or equal to 33.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) (e.g., if the required ratio is 0.100, less than or equal to a ratio of 0.033), or 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than or equal to 33.0 percent of the

		applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) for the same major monitor. (b) With respect to 2022 through 2025 model year engines, the average in-use monitor performance ratio for one or more of the major monitors in the test sample group is less than or equal to 20.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) (e.g., if the required ratio is 0.300, less than or equal to a ratio of 0.060), or 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than or equal to 20.0 percent of the applicable required minimum ratio established in Cal. Code Regs., title 13, section 1971.1(d)(3.2.2) for the same major monitor.
		The Monitoring System Demonstration test protocol is an engineering exercise that has the primary goal of demonstrating the ability of the OBD system to detect the BPU fault and provide an accurate assessment of the emissions performance of the BPU system. While the CARB proposal can serve as a baseline expectation to conduct monitoring system demonstration, it is too inflexible to cover all the technical issues that arise in designing robust diagnostics that meet the in-use performance ratio requirements. As has been CARB's long standing practice, CARB should continue to use the provision in (i)(1.2) to approve deviations to the protocol outlined in (i)(4.1) as necessary to promote sound diagnostic design. As an example, these deviations include rearranging the order of the preconditioning and demonstration tests, allowing additional preconditioning cycles, vehicle level demonstration drive cycles, etc. The ISOR contains a comment 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 . . .". This statement ignores a whole class of diagnostics that monitor the control system adaptation and use it as an indication of a fault. In these systems, "stabilization of the emission control system" is identical to "learning or adapting of the diagnostic". In addition, the example given (EWMA) is also a poor example since CARB has allowed (and should continue to do so) use of the precondition cycle as part of the fast initial response function as needed on a case by case basis.

CARB Has Failed to Comply With
<u>the Applicable CEQA Requirements</u>

CARB is required to comply with the California Environmental Quality Act (CEQA) through its own certified regulatory program when it seeks to adopt or amend regulations. (Pub. Resources Code § 21080.5; 14 CCR §§ 15250-15253 ("CEQA Guidelines"); 17 CCR §§ 60005-60007.) CARB also is required to comply with the California Administrative Procedures Act (APA) (Gov't. Code §§ 11350, et seq.), which, among other things, requires CARB to prepare a Standardized Regulatory Impact Assessment (SRIA) and to assess in detail the economic impacts of the proposed HD OBD amendments. CARB has failed to meet its requirements under CEQA and APA, and has failed to prepare the necessary SRIA.

Under the APA, state agencies proposing to "adopt, amend, or repeal any administrative regulation" must first perform an assessment of "the potential for adverse economic impact on California business enterprises and individuals." (Govt. Code, § 113456.3(a).) Among other things, the APA requires that agencies such as CARB prepare a Standardized Regulatory Impact Assessment ("SRIA") analyzing "the potential adverse economic impact on California business and individuals or a proposed regulation," (Govt. Code, § 11346.3), and declare in the notice of proposed action any initial determination that the action will not have a significant statewide adverse economic impact directly affection business. (Govt. Code, § 11346.5, subd. (a)(8); *WSPA*, *supra*, 57 Cal. 4th at 428.) The APA requires the SRIA to evaluate several issues, including "elimination of jobs within the state," "the elimination of existing business within the state," and "[t]he competitive . . . disadvantages for businesses currently doing business within the state." (Govt. Code, § 11346.3(c)(1)(A)-(C).) The SRIA must be circulated with the 45-day materials (in this instance, the ISOR), and must be supported by "facts, evidence, documents, [or] testimony," and made available for public review and comment for at least 45-days before an agency approves a regulation. (Govt. Code, §§ 11346.5(a)(7), (a)(8), 11347.3(b)(4).) The SRIA cannot be based on "mere speculati[on]." (*WSPA*, *supra*¸57 Cal. 4th at 428.) "A regulation . . . may be declared invalid if . . . [t]he agency declaration [regarding adverse economic impacts] is in conflict with substantial evidence in the record." (*Calif. Assn'n of Medical Products Supplies v. Maxwell-Jolly* (2011) 199 Cal.App.4th 286, 306.)

The current Economic Impacts Assessments (EIA) contained in the ISOR for the HD OBD amendments does not meet the applicable SRIA standards. It fails to analyze in an adequate manner the "potential adverse economic impacts on California business and individuals," including due to the potential unavailability of California-certified HDOH engines from and after the 2022 model year. Similarly, the current SRIA also fails to analyze "the competitive disadvantages for businesses currently doing business within the state." Those businesses that rely on HDOH vehicles will see increased relative costs at best, and could face the prospects of a significant shortage of new CARB-compliant HDOH vehicles in California. Finally, the ISOR for the HD OBD amendments fails to discuss in a sufficient manner the potential adverse environmental consequences of the amendments – including the significant incentives that HDOH vehicle owners could have to "pre-buy" and retain older vehicles – which is inconsistent with CARB's obligations under CEQA.

The EIA that CARB has included in the pending ISOR is deficient in numerous fundamental ways. Most importantly, there is no sufficient basis for CARB's unilateral assertion that "the proposed amendments are exempt from the requirements of CEQA" because "CARB has determined there is no substantial evidence indicating that the proposal could adversely affect air quality." (2018 ISOR, p.173,175.) In that regard, CARB has failed to consider the reasonable possibility that the pending rulemaking could lead to the unavailability of new CARB-certified HD engines for HDOH vehicles sold in California, which could cause significant cost increases for the remaining new HDOH engines and vehicles sold in California that attempt to meet the requirements of the pending HD OBD amendments. Those two predictable outcomes — product unavailability and/or significant increases in price for remaining products — could drive HD fleet owners and operators in California to retain their aging HDOH vehicles and engines longer than they otherwise would, resulting in significantly slower fleet turnover (through pre-buy/no-buy behaviors) and an increase in the relative amount of aggregate emissions.

A number of salient facts bear this out. Foremost among them is that HDOH engine manufacturers could be compelled to exit the California market, and instead focus on the manufacture and sale of EPA-certified 49-state products, due to the expansive suite of expensive and infeasible California-only regulations that CARB is proposing to adopt by the end of 2019, including the pending HD OBD amendments. It is reasonably foreseeable that HDOH engine manufacturers faced in the 2022 or 2023 model year with a unique array of California-only requirements for a new dramatically lower tailpipe NO_x standard, a new low-load certification cycle, an expanded series of in-use testing requirements, further expanded warranty and durability requirements, and substantially increased OBD requirements (including increased IUMPRs and new NO_x/fuel-consumption tracking and binning requirements) and deficiency fines, could determine that it is no longer feasible or economically viable to manufacture and sell CARB-certified products. CARB's EIA completely fails to consider any of the ramifications of that distinct possibility.

In addition, as noted above, CARB's assessment of the cost impacts of its HD OBD program is understated by orders of magnitude. Numerous factors contribute to CARB's "undercounting," but one example helps to illustrate the scope and degree of the undercounting of CARB's HD OBD program. By way of example, in preparing its EIA, CARB includes no assessment whatsoever of the likely cost impacts of the proposed substantial increases in OBD deficiency fines. That is a fundamental oversight because, as CARB well knows, the highly complex and onerous nature of CARB's HD OBD requirements forces most, if not all, HDOH engine manufacturers to rely on one or more (in several cases, substantially more) OBD deficiencies in making their OBD-certification applications to CARB. As a result, it is a virtual certainty that most, if not all, HDOH engines sold into California from and after the 2021 model year will carry deficiency fine surcharges ranging from $750-$1,500 per engine. That amount on its own is roughly 4-7 times larger than the amount that CARB has ascribed to its entire HD OBD program ($207.86 per engine). CARB's complete failure to consider those virtually certain deficiency-fine impacts in its EIA is representative of the lack of technical thoroughness, accuracy and reasonableness of that EIA. When that failure is coupled with CARB's other order-of-magnitude understatements of the costs of the HD OBD program, it is clear beyond dispute that CARB has failed to account fully or fairly for the significant costs at issue, and the resulting likely ramifications on the HDOH engine and vehicle market, including the potential adverse environmental ramifications as California HDOH fleet owners and operators are compelled to hold on longer to their aging vehicles.

That is not an insignificant oversight on CARB's part. Rather, it undermines the main premise for CARB's claim that the pending HD OBD amendments cannot adversely affect air quality. CARB's core premise in that regard is that the costs of its programs can be assessed in the context of manufactures' nationwide sales "because virtually all heavy-duty engine manufactures 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." (2018 ISOR, p. 180.)

> To date, virtually all engine and vehicle manufacturers have chosen to design a single HD OBD 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 be experienced by non-California businesses due to the federal requirements. (2018 ISOR, p. 192.)

CARB's core premise cannot be assumed any longer. The increasing costs of CARB's HD OBD regulations, coupled with CARB's expansive suite of additional California-only HDOH regulations slated for adoption within the next 13 months, make it increasingly likely that HDOH manufacturers could consider turning to EPA for the certification of 49-state products, thereby resulting in the foreseeable adverse impacts on the availability and costs of products in California that CARB has tried to assume away. In that regard, it is noteworthy that EPA's HD OBD regulations do not include an MST program, deficiency fines, or any of the HD OBD amendments at issue. All of that further undermines the continuing validity of CARB's core premise.

Contrary to CARB's unsupported assertions, a potential result of CARB's pending rulemakings is significantly increased costs and instances of product unavailability for new HDOH engines in California. That would have significant and readily foreseeable adverse impacts on California-based businesses and on the environment as HDOH fleet owners and operators retain and "pre-buy" older model year HDOH engines and vehicles. CARB's attempt to assume that those impacts are not foreseeable, and its assertion that "there is no substantial evidence" for any adverse effects, are incorrect and unreasonable. As a result, CARB's EIA is similarly unreasonable, as is CARB's related failure to comply with CEQA, including through the preparation of a thorough SRIA. *See Lawson Rock & Oil, Inc. v. State Air Resources Board*, Cal. Ct. App., 5th Dist. (Case No. F074003)(2018).

Conclusion

CARB again is proposing to expand its prescriptive-based HD OBD regulations, which are already cost-prohibitive, and which, in the aggregate, exceed CARB's delegated authority. That proposed expansion could frustrate the development and consideration of a potential highly-beneficial paradigm shift to performance-based in-use-focused emission regulations for HDOH engines and vehicles in the 2027 timeframe, and could preclude the implementation of EMA's proposed interim nationwide low-NO_x program in 2024. In addition, a potential outcome of CARB's rulemaking proposal could be a fracture and significant disruption of the HDOH engine and vehicle market in California, as manufacturers could be increasingly compelled to consider EPA certification of 49-state products. That, in turn, would occasion pre-buy/no-buy responses from HDOH fleet owners and operators in California, and would frustrate and forestall important air quality attainment goals. Those potential results also mean that one of CARB's core rulemaking assumptions – that the costs of its HD OBD program can be amortized across nationwide sales volumes of HDOH engines and vehicles – is no longer valid, which renders the regulations at issue that much more cost- prohibitive and that much farther beyond the scope of CARB's authority.

The Board should not approve the pending HD OBD amendments. Rather, the Board should direct its staff to conduct and produce a detailed and comprehensive assessment of the aggregate cumulative (and annual) costs relating to the implementation of all of CARB's HD OBD regulations, and should further direct staff to develop proposals for streamlining, not expanding, those regulations so that they comport with the inherent limits on CARB's authority and better align with a potential paradigm shift to performance-based regulations.

Respectfully submitted,

TRUCK & ENGINE
MANUFACTURERS ASSOCIATION

Exhibit A

Table F-1. Average Engine Manufacturer Major Costs of Proposal				
	CARB			EMA Ave.
HD OBD Proposal	Total Cost	Total Annual Cost		Total Cost
IUMPR - Increase all monitors to 0.3 - 2022+MY	$401,567	$66,928		$ 255,360
IUMPR - Require new diesel monitors to track and report data - 2022+MY	$2,200	$367		$ 461,875
PHEVs - require 2 ignition cycle counters - 2022+MY	$4,200	$700		$ 23,733
Change freeze frame requirements - 2022+MY	$4,200	$700		$ 514,541
Monitoring Conditions - restrict SET cycle conditions to monitors that are IUMPR tracked and reported - 2022+MY	$1,346,162	$224,360		$ 79,333
Limit emissions-increasing intrusive diagnostics to run only after MIL already on	$15,000	$2,500		$ 333,333
Add NOx emission thresholds to PM filter filtering performance monitor and catalyzed PM filter conversion monitor - 2022+MY	$0	$0		$ 29,667
EGR/Boost continuous monitors - add similar conditions requirements - 2022+MY	$1,000	$167		$ 131,199
New NOx sensor monitor requirement - indicate fault when goes "inactive" when it should be "active" - 2022+MY	$186,216	$31,036		$ 140,825
Add more stringent CV monitoring requirements - 2025-2027 MY phase-in	$75,409	$12,568		$ 295,799
DDE - Change engine durability aging requirements	$694,756	$694,756		$ 303,750
PVE (l)(2) - Require testing of 10 monitors already tested during DDE testing	$1,000	$1,000		$ 11,213
Readiness - add separate diesel exhaust gas sensor heater readiness bit for J1939 vehicles and add gasoline O2/exhaust gas sensor heater bit; for 2022+MY, take PM filter frequent regen and active/intrusive injection out of readiness	$1,000	$167		$ 450,000
New NOx performance control tracking parameters - 2022+MY	$19,900	$1,990		$ 485,217
New GHG-related parameters - 2022+MY	$13,400	$1,340		$ 384,122
New over the air reprogramming requirements - 2022+MY	$26,400.00	$2,640		$ 100,267
New certification doc requirements (e.g., torque PIDs correlation, Nox sensor status flag, 1Hz data showing the instantaneous NOx mass emission rate)	$2,000	$2,000		$ 265,675
Totals w/o MST	$2,794,410	$1,043,219		$4,265,910

Exhibit B

1. Summary

ARB's cost estimate for the NOx binning proposal is not only wrong, it illustrates a lack of understanding about creating software of production scale and magnitude. ARB's estimate to develop one software feature is too low by a factor of 14 for the first engine family. The overall estimate is too low by a factor of more than four.

Realizing that the cost estimates are grossly low, the ARB Board should request that an external, independent firm do a completely new cost estimate of the HD OBD program.

Furthermore, when the factor of four is applied to the NO_x and fuel-consumption tracking proposals, the cost of the program balloons. ARB has written in the rule that the NOx binning information will not be used for compliance purposes. In other words, ARB is forcing manufacturers to spend large amounts of money on what amounts to an ARB research project.

The Board should remove the NO_x and fuel-consumption tracking proposals from the OBD regulation.

2. Introduction

As part of the biennial rulemaking package, ARB created Appendix F, "Economic Analysis Support." Rather than respond in detail to the entire Appendix, this white paper analyzes a single entry in detail. The analysis shows two key facts.

1. ARB does not grasp the challenges associated with writing software of the scope and complexity of modern engine software.
2. ARB's cost estimates are dramatically low.

ARB's entire development cost estimate is too low by a factor of at least four.

3. ARB Cost Estimate: "Readiness Work Package"

To focus the argument, consider a single estimate in ARB's cost estimate. On page 3 of Appendix F, the first line is "Readiness – add separate diesel exhaust gas sensor heater readiness bit for J1939 vehicles and add gasoline O2/exhaust gas sensor heater bit; for 2022+, take PM filter frequent regen and active/intrusive injection out of readiness". We refer to this item as the *readiness work package.*

ARB's cost estimate for industry to implement the readiness work package is shown in the first row on page 3, and it is $200 for algorithm development and programming, or less than half of a day of a full-time employee (FTE). That estimate is completely unreasonable from an industry perspective.

The estimate suggests a software development process where a single person has the entire software in her head. Such a paradigm has nothing whatsoever in common with creating and maintaining modern engine software. Writing or modifying the source code is only a single task out of many that must be performed, and writing the source code is by far not the largest task. ARB then multiplies this effort by the number of engine families. For a large manufacturer with ten engine families, they estimate this feature will have a total cost of $2,000.

4. Industry Cost Estimate

To help explain how flawed ARB's estimate is, one member of EMA has prepared the cost-assessment table below. This company follows a software development process based on the SPICE standard, and the table presents a likely scenario for the size, quantity, and cost of the tasks to implement the readiness work package.

Table 1 Development Effort For The Readiness Work Package

Task	Sub-Tasks	FTEs involved	Estimated FTE hours
Updating requirements documents	Analyze the regulations; identify the proper documents to be updated; edit the document; plan, organize, and hold a peer review meeting; process any feedback from the meeting	regulatory analyst software requirements writer testing team managers of above as requirements are modest, the peer review meeting will short or might be done wholly in email	4
Converting regulatory requirements into software requirements	Analyze the new regulatory requirements documents in terms of software; identify the proper software requirements documents; update document(s); plan, organize, and hold a peer review meeting; process any feedback from the meeting	regulatory analyst (who must agree the software design will achieve the regulatory goals), software writer, unit testing team, managers;	4 a single 1 hr conversation/meeting with 3 engineers consumes 3 FTE-hrs; the outcome of that meeting would need to be documented afterwards in a formal engineering document
Writing the actual software	Programmers, likely at an external organization and likely in a different time zone, modify/write the actual software.	programmers; conversations with the requirements writers possible	3 FTE hrs
Management and PM oversight	This workpackage is regulatory, and it is likely to show up in regular management review meetings. If this topic gets 2 mins in a steering committee meeting where 30 people call-in, then it has consumed 1 FTE-hr.	Project managers, chief engineers, directors of regulatory compliance, engineering managers and supervisors	2 FTE-hrs assuming it is a 2 min agenda item in 2 steering committee meetings If there are bugs or problems, then much more management support would be needed.

Unit testing software	Test cases must be created and documented. The test cases will be discussed, perhaps with requirements writers. They will be tracked in various tool chains.	Testers, requirements writers	2 FTE-hrs to create and run the tests. Likely, the tests will uncover bugs or other problems. Troubleshooting is highly variable and highly time intensive.
Vehicle final verification testing	In addition to software unit testing, the functionality must be tested on a vehicle.	testers, requirements writers	2 FTE-hrs to create, run, and document the tests. If the diagnostic is difficult to run, then it could be harder. For example, some diagnostics require an overnight soak or similar hard-to-get conditions.
Debugging	Testing typically uncovers problems. Sometimes the test execution was flawed, sometimes the tests were badly designed, sometimes the software was implemented wrong, and sometimes the software correctly implements a flawed regulatory analysis	Variable; Could include any of the following: PM, chief engineers, director of regulatory compliance, test engineers, software requirements writers, regulatory analysts Multiple alignment meetings are likely to be needed; each 30 min meeting with 4 engineers consumes 2 FTEs	20 FTE hrs is likely, and it is possible to be much higher
Documentation	These new features will need to be properly documented in the certification application.	Documentation specialist and/or technical writer Regulatory specialist	2 FTE-hrs Though the changes are small, multiple subject matter experts will need to be coordinated
Q&A with ARB	These being new features, ARB is likely to ask specific, detailed questions	Any of the above could be consulted, depending on the questions from ARB	4 FTE-hrs Collecting the information and gathering it into a form that ARB can consume is time intensive, and requires highly skilled people

Altogether, the foregoing tasks sum to a total of 43 FTE hours for the readiness work package. Assuming an average in-house FTE-hour costs $75 per hour, this work would cost $3,225 as opposed to ARB's estimate of $200. **ARB's estimate is too low by a factor of over 14 for the initial development of this single element.**

ARB also provides an estimate for a large manufacturer with 10 engine families. Assume that for engine families 2 through 8, the software is "cut-and-paste" with minimal engineering effort. Also assume that for engine families 9 & 10, a special problem occurs that leads to significant effort. For example, when the software is ported to those engine families, a new bug occurs.

Table 2 Effort To Deploy The Feature Across Multiple Families

Engine Family	FTE-hrs	Notes
1	43	initial SW development
2	4	cut-and-paste development + basic testing & documentation
3	4	cut-and-paste development + basic testing & documentation
4	4	cut-and-paste development + basic testing & documentation
5	4	cut-and-paste development + basic testing & documentation
6	4	cut-and-paste development + basic testing & documentation
7	4	cut-and-paste development + basic testing & documentation
8	4	cut-and-paste development + basic testing & documentation
9	20	This family requires extra work.
10	20	This family requires extra work.
Total FTE-hrs	111	

Assuming the average cost cost (including benefits) of an FTE-hr is $75 per hour, then the cost of this effort is over $8,300, more than four times (4.2x) ARB's estimate of $2,000.

Exhibit C

Ten Dollar Hardware Change

The proposed hardware costs per unit are anticipated to increase by 10 dollars ($10.00) according to the cost estimate given in the ISOR and Appendix F, Table F-1. That figure is not representative of the actual costs. First, each manufacturer will need to install additional memory into their own engine ECM(s). Then, the engine ECM must be requalified for its functional, environmental and lifetime expectations. Those costs, borne by each manufacturer, are then amortized by the individual manufacturer's annual sales and not an industry average annual volume. Few HDDE manufacturers approach automotive-scale volumes in excess of 200,000 ECMs per year and can share hardware development costs with an LDDE platform.

New microcontroller chips with additional memory cannot be assumed to be capable of being substituted within a current ECM's bill of material and then be given a brief functional check. The new microcontroller chips may have domino effects that require additional modifications to the ECM's printed circuit board. For example, if the footprint of the microcontroller chip does not match, exactly, the footprint of the existing microcontroller then the printed circuit board must be modified to match the footprint of the new micro controller, its particular design rules, and the production process must be requalified to ensure that the solder reflow for the revised part placement is correct.[1]

If the new microcontroller chip requires more power than the old microcontroller, then the power supply circuit will be changed to provide the additional current. Increases in power imply increases in heat rejection from the microcontroller package. The finite element analysis to affirm the microcontroller manufacturer's maximum junction temperature (Tj) will be recalculated using the new inputs.[2] Temperature chamber tests will be conducted to affirm that the model's predictions can be relied upon. In some cases, the changes to the printed circuit board may not be capable of reusing the existing housing. New die cast tooling for an aluminum clamshell would be needed to protect the printed circuit board and adapt it for mounting to the engine.

The new ECM part number must be approved through the Production Part Approval Process (PPAP) which requires that all key functional criteria are still met as well as the unchanged part met the functional requirements. They also may need to be qualified in a vehicle trial that is judged using statistical analysis based on the Weibull curve.[3]

Example test planning tool output is shown in Table W for a vehicle trial that assumes Weibull analysis is to be used for collected data. Table W shows the mileage accumulation required, and test years anticipated for a given set of statistical goals. Even for a low B10 reliability goal of 300,000 miles (against an industry goal for 1.2 million miles of service life for vehicles with HHDEs) and low confidence of 75 percent, nearly twenty trucks with an annual test expectation of 4000 hours per vehicle at 40 miles an hour are needed to qualify a new ECM in under 18 months. The costs of the vehicles, the wages of the drivers and the fuel expenses are not in CARB staff's estimates for a memory improvement.

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[1] For design consideration examples see NXP Semiconductors, "AN10778 PCB Layout Guidelines for NXP MCUs" in BGA packages at https://www.nxp.com/docs/en/application-note/AN10778.pdf, NXP Reference Design Board KW01-RCD-RD at https://www.nxp.com/docs/en/user-guide/KW01RCDRDUG.pdf, and Texas Instruments, "PCB Design Guidelines for 0.5mm Package-on-Package Applications Processor, Part I, SPRABB3—June 2010" at http://www.ti.com/lit/an/sprabb3/sprabb3.pdf,

[2] For example microcontroller requirements see page 4 spec. 26, Maximum operating temperature range die junction temperature, NXP semiconductors ,"MPC5554 Data Sheet, Rev 4", https://www.nxp.com/docs/en/data-sheet/MPC5554.pdf

[3] For example, see https://www.sae.org/publications/technical-papers/content/1999-01-2859/

Table W Sample Plan Tool Results for HDDE ECMs

COMPONENT RELIABILITY DEMONSTRATION (ZERO-FAILURE) TESTING

- MINIMUM SAMPLE SIZE AND TEST MILES

				TEST UNITS	MILES PER UNIT	TOTAL MILES	TEST YEARS
B	**10**	**LIFE (MILES):**	**300,000**	3	1028414.481	3085243.444	6.4276
		MTBF EQUIVALENT:	**1,840,717**	4	809193.843	3236775.372	5.0575
				5	671883.886	3359419.430	4.1993
		CONFIDENCE:	**75%**	6	577178.113	3463068.676	3.6074
		BETA:	**1.20**	7	507599.122	3553193.855	3.1725
				8	454144.689	3633157.514	2.8384
		Test Hours / Year	4000	9	411686.985	3705182.868	2.573
		Average Speed	40	***10***	***377082.082***	***3770820.815***	2.3568
				11	348290.791	3831198.699	2.1768
				12	323930.263	3887163.160	2.0246
				13	303028.239	3939367.108	1.8939
				14	284880.375	3988325.253	1.7805
				15	268963.396	4034450.942	1.681
				16	254880.089	4078081.425	1.593
				17	***242323.274***	***4119495.657***	1.5145
				18	231051.508	4158927.151	1.4441
				19	220872.287	4196573.455	1.3805
				20	***211630.163***	***4232603.256***	1.3227
				21	203198.181	4267161.810	1.27
				22	195471.597	4300375.140	1.2217
				23	188363.188	4332353.326	1.1773
				24	181799.713	4363193.122	1.1362
				25	175719.202	4392980.045	1.0982
				26	170068.849	4421790.073	1.0629
				27	164803.372	4449691.032	1.03
				28	159883.705	4476743.733	0.9993
				29	155275.963	4503002.921	0.9705
				30	***150950.602***	***4528518.068***	0.9434
				35	132753.463	4646371.204	0.8297
				40	118773.413	4750936.520	0.7423
				45	107669.361	4845121.230	0.6729
				50	98619.068	4930953.380	0.6164
				55	91089.221	5009907.153	0.5693
				60	84718.161	5083089.667	0.5295
				65	79251.611	5151354.707	0.4953

Commonly, tests included in PPAP data collection reflect Table 4 of SAE J1455™ [March 2017]. These tests are performed in addition to the functional tests associated with the device. For an engine control module, there may be functional tests to confirm the current control waveforms and timing for fuel control systems. Table X lists the expected environmental tests from SAE J1455 Table 4 for new products like an Engine ECM, which are commonly mounted on the side of the engine. Section 4.13 lists a number of SAE J1113™ and other tests. The HD industry agrees in SAE J1455 that these tests are relevant to HD vehicle electronics, and therefore relevant to the creation of a new or the modification of an existing engine control module. [4]

Among those tests are temperature cycling protocols to the underhood temperature guide shown in Table 4 of SAE J1455 as -40 to 141 degrees Celsius. Figure Y lists the tests recommended by SAE J1455. Several among these have been highlighted as items which would never be thrifted as unnecessary. In particular, the electromagnetic compatibility tests listed in paragraph 4.13.3 of SAE J1455 would not be skipped for circuit board changes. Testing to paragraph 4.13.3 by an independent, certified laboratory exceeds the 10,000 cost in the ISOR.

Table X -- SAE J1455™ Table 4 - Engine - environmental data [5]

Temperature	Min	Max	Humidity	Salt Spray	Immersion and Splash	Direct Spray Steam Clean Pressure Wash	Sand Dust and Gravel	Mechanical Vibration and Shock	Altitude	Electrical
Under-hood	–40 °C	141 °C								
Lower	(–40 °F)	(285 °F)	4.2	4.3	4.4	4.5	4.7 and 4.8	4.10 and 4.11	4.9	4.13
Upper	–40 °C	307 °C								
	(–40 °F)	(585 °F)								
Bulkhead	–40 °C	141 °C								
	(–40 °F)	(285 °F)								

[4] SAE International, SAE J1455™ Recommended Environmental Practices for Electronic Equipment Design in Heavy-Duty Vehicle Applications, March 2017 available at https://www.sae.org/standards/content/j1455_201703/. SAE J1455™ is a trademark of SAE International, Inc.

[5] SAE International, SAE J1455™ Recommended Environmental Practices for Electronic Equipment Design in Heavy-Duty Vehicle Applications, March 2017 available at https://www.sae.org/standards/content/j1455_201703/

Figure Y SAE J1455 Test Recommendations

4.1 Thermal Cycling to Figure 2 of SAE J1455
4.2 Humidity
4.3 Salt Spray Atmosphere
4.3.3.1 Salt Spray (Fog) to ASTM B117
4.3.3.2 Immersion Testing
4.5 Steam Cleaning and Pressure Washing
4.6 Fungus to MIL STD 202G
4.7 Dust and Sand to ASTM C150-56
4.8 Gravel Bombardment
4.9 Altitude to Air Cargo Decompression standard.
4.10. Mechanical Vibration
4.10.4.1 Swept Sine Vibration Tests
4.10.4.2 Random Vibration Testing
4.10.4.3 Vehicle Testing
4.11.2 Mechanical Shock Tests
4.11.3.2 Transit Drop Test to ASTM D5276 and D880; TAPPI T-801 and T-802.
4.11.3.3 Installation Harness Shock Test
4.11.3.4 Operational Shock
4.11.3.5 Crash Shock Test

4.13.2.2.1 Electrical tests to SAE J1113-11 et. al.
- a. Load Dump (Pulse 5C)
- b. Inductive Switching (Pulse 1 and Pulse 2)
- c. Burst Transients (Pulse 3a and Pulse 3b)
- d. Starter Motor Engagement (Pulse 4) –

4.13.2.2.2 Coupled Transients to SAE J1113-12
- a. Electrical Fast Transients
- b. Chattering Relay

4.13.2.2.3 Electrostatic Discharge (ESD) to SAE J1113-13
- 4.13.2.2.3.1 Handling
- 4.13.2.2.3.2 In Vehicle

4.13.2.2.4 Other Effects
4.13.3 Electromagnetic Compatibility (EMC) Requirements
- 4.13.3.4.1 Radiated Emissions Section 6 of CISPR 25.
- 4.13.3.4.2 Radiated Electric Field Immunity SAE J1113-21.
- 4.13.3.4.3 Radiated Magnetic Field Immunity ISO 11452-8.
- 4.13.3.4.4 Conducted Emissions, DC Power Leads Section 6 of CISPR 25.
- 4.13.3.4.5 Conducted Immunity, DC Power Leads ISO 11452-10.

Exhibit D: Alternative Proposal for Lifetime NOx Binning and Fuel Consumption Tracking

Row	Reg.Ref Function	Data Stream (h)(4.2.2)	Run Time Tracking (h)(5.2.1)	NOx Binning (h)(5.3.3)				Fuel Consumption Tracking (h)(5.4)		
				NOx Sensors Active			Engine Activity [Bin 1 is Σ]	Active 100h	Stored 100h	Lifetime (EA)
				Active 100h	Stored 100h	Lifetime				
1	Distance	***Odometer***		~~x~~	~~x~~	(5.3.1)(D)	(5.3.1)(D)	~~y~~	~~y~~	(5.4.5)
2	Engine Hours		***(5.2.1)(A)***	~~x~~	~~x~~	(5.3.1)(E)	(5.3.1)(E)	~~y~~	~~y~~	(5.4.10)
3	Idle Run Time		(5.2.1)(B)				Note A	~~y~~	~~y~~	(5.4.11)
4	PTO Run Time		(5.2.1)(C)				Note A	~~y~~	~~y~~	(5.4.13)
5	NOx kg Engine			~~x~~	~~x~~	(5.3.1)(A)				
6	NOx kg Tailpipe			~~x~~	~~x~~	(5.3.1)(B)				
7	Eng. Output Energy			x	x	(5.3.1)(C)	(5.3.1)(C)	y	y	(5.4.7)
8	Fuel Consumption (Vehicle)			~~x~~	~~x~~	(5.3.1)(F)	(5.3.1)(F)	~~y~~	~~y~~	(5.4.1)
9	Fuel Consumption (Engine)									(5.4.2)
10	Engine Idle Fuel							~~y~~	~~y~~	(5.4.3)
11	Engine PTO Fuel							~~y~~	~~y~~	(5.4.4)
12	Engine WHR Dist							~~y~~	~~y~~	(5.4.6)
13	WHR Output Energy							~~y~~	~~y~~	(5.4.8)
14	PKE (Ratio)							~~y~~	~~y~~	~~(5.4.9)~~
15	Urban Speed Time							~~y~~	~~y~~	(5.4.12)
16	Start/Stop Time							~~y~~	~~y~~	(5.4.15)
17	AES Shutdown Count							~~y~~	~~y~~	(5.4.16)
18	Active Tech 1 Time							~~y~~	~~y~~	(5.4.17)
19	Active Tech n Dist							~~y~~	~~y~~	(5.4.22)
20	No DEF Time		(5.2.1)(E)(i)							
21	Low Exh. Temp.		(5.2.1)(E)(ii)							

Above: x x …. And y y denote separate 100h clocks used by NOx Binning and fuel consumption Tracking.

A: Bin 2 of engine runtime will be the sum of idle and stationary pto hours

B: (section (h)(5.7.2)(C) [fuel consumption Lifetime Category] requirements for these parameters were noted in industry discussions with CARB staff as duplicated content to be addressed.

C: (sections (h)(5.7.2)(B) and (C) [fuel consumption Stored 100 h and Lifetime Category requirements for these parameters were noted in industry discussions with CARB staff as duplicated content to be addressed.

Exhibit E – NVRam Requirements in Proposed 13 CCR 1971.1

The NVRAM requirements for the current 13 CCR 1971.1 rule can be estimated as shown in Table 1. The existing rule can be shown to require at least 2,296 bytes of NVRAM storage.

Table 2 shows the increase in NVRAM requirements for NOx Binning and Fuel Consumption Tracking alone. Table 2 excludes additional effects for similar conditions and other data that varies across engine starts. The total for a single copy of the NOx Binning and Fuel Consumption Tracking data elements is 2,384 bytes of new information to be stored across ignition key cycles. Accounting for the limitations of NVRAM (or flash memory technology), 20,480 bytes are needed. This represents a ***ten-fold*** increase over the requirements in Table 1. The detailed calculations for Table 2 are shown in Table 3. This increase will challenge manufacturers to increase the NVRAM content in their engine control modules.

Flash NVRAM technology requires that an entire memory block be erased before individual memory locations can be reused for new data values. The memory blocks are of a given size. For this estimate, an NVRAM memory block size of 512 bytes is assumed. Since all 512 bytes are erased, the storage requirement must accept that there must exist some overhead memory locations. For this estimate, 2,192 bytes of information are defined to fit in 5 512-byte NVRAM blocks for a length of 2,560 bytes. But this number of bytes is not all that is required to support NOx Binning and Fuel Consumption Tracking. Multiple memory locations are required, as is discussed in the next paragraph. When the 2,560 bytes are multiplied by the [assumed] eight memory locations, an overall total of 20,480 bytes are needed to implement data storage for the NOx Binning and Fuel Consumption Tracking arrays in draft 13 CCR 1971.1 (h)(5.3) and (h)(5.4).

It is widely known that NVRAM technology does not provide infinite life in terms of the number of times a value can be written into an individual memory location. In fact, NVRAM technology exhibits a wear-out phenomenon. Therefore data that is to be stored frequently must have multiple memory locations provided for it to achieve the product life goals for heavy-duty diesel engines. A "ring of eight" strategy can be employed to provide the multiple memory locations. In a "ring of eight" strategy, each data item is allocated eight memory locations in NVRAM. The data storage routine rotates the memory locations such that each of the eight locations is used equally, that is, utilized for one-eighth of the storage events. The life estimate for the NVRAM locations is summed across the eight locations to provide the expected life for the ring of eight storage method.

HD manufacturers do not use battery backed RAM (or Keep Alive Memory (KAM)) for such requirements, because many heavy-duty vehicle owners are known to disconnect the vehicle's batteries. This action causes the data, intended to be stored across key cycles, to become lost. Also, battery-backed RAM can be disturbed by the voltage drop that is experienced when the starter motor is engaged on a Diesel engine. Indeed, a reset of an ECM during engine start is a known phenomenon. Thus, the existing requirements in Table 1 are affirmed to require NVRAM as opposed to battery backed RAM.

Industry and CARB staff also discussed the use of 4-byte parameters for the 100 hour arrays. Table 4 shows the effects of such a choice. A demand for 4 byte parameters in the active and stored 100 hour arrays will increase the NVRAM size needed by over 8,000 bytes to 28,672. The 16 bins in the NOx Binning proposal times 6 parameters for each bin drive this dramatic increase.

Publicly available information from NXP suggests that applications with a high demand for NVRAM may challenge existing microcontrollers [once] used for engine controls. See https://www.nxp.com/docs/en/application-note/AN4868.pdf. Even though an individual microcontroller may have 4 MB of flash data in the same ball-grid array package as the microprocessor, only a fraction of the flash data is configured to emulate EEPROM memory that would be used to for NOx Binning and Fuel Consumption Tracking data. Manufacturers with a high utilization for that data today would be forced to migrate to a new microcontroller family to obtain additional memory. The implications of hardware changes are discussed above in Exhibit C.

Table 1 Existing NVRAM Requirements in 13 CCR 1971.1

Row	Bytes	Use
1	1024	Storage of 85 test results at 12 bytes per test result for SPN, FMI, Test Value, Test Minimum and Test Maximum, as suggested by SAE J1939-73 message DM30.
2	344	Diagnostic Test Codes (fault codes). 4 bytes long for SPN and FMI. Assumes 16 DTCs for SAE J1939-73 messages DM1, DM2, DM6, DM12, and DM23. Assumes 8 DTCs for DM28, Permanent DTCs.
3	280	IUMPR numerators and denominators contributing to the display in SAE J1939-73 message DM20 (220 bytes). EI AECD timers displayed in SAE J1939-73 message DM34. (60 bytes).
4	528	Freeze Frame Display, SAE J1939-73 message DM25. 4 freeze frames at 132 bytes each .
5	120	VIN and Engine Serial Number
6	2 296	Total

Table 2 Increased NVRAM Requirements for NOx Binning and Fuel Consumption Tracking

Row	Bytes	Use
1	384	NOx Binning Active 100 Hour Arrays
2	192	NOx Binning Stored 100 Hour Arrays
3	768	NOx Binning Lifetime Arrays
4	512	NOx Binning Engine Activity Arrays
5	1 856	NOx Binning Subtotal
6	96	Fuel Consumption Tracking Active 100 Hour Arrays
7	48	Fuel Consumption Tracking Stored 100 Hour Arrays
8	192	Fuel Consumption Tracking Lifetime Arrays
9	336	Fuel Consumption Tracking Subtotal
10	2 192	Total (NOx Binning + Fuel Consumption Tracking)
11	2 560	Flash Ram Technology Adjustment to 5, 512 byte blocks
12	20 480	Flash Ram Technology Adjustment for limited write cycle life

See Table 3 for a detailed explanation of the data bytes needed for each array.

Table 3 NVRAM Memory Increase Detailed Estimate (5 Engine Controlled Active Technologies)

Row		NOx Binning (h)(5.3.3)				Fuel Consumption Tracking (h)(5.4)		
		NOx Sensors Active			Engine Activity [Bin 1 is Σ]	Active 100h (5.7.2) (A)	Stored 100h (5.7.2) (B)	Lifetime (EA) (5.7.2) (C)
		Active 100h	Stored 100h	Lifetime				
1	Number of Bytes Per Element	2	2	4	4	2	2	4
2	Number of Elements per Parameter	16	16	16	16	1	1	1
3	Number of Parameters	6	6	6	4	14+10	14+10	14+10
4	Row 1 * Row 2 * Row 3	192	192	384	256	48	48	96
5	Intermediate Values Allowance (=Row 4)	192	0	384	256	48	0	96
6	Array Subtotals (Row 4 + Row 5)	384	192	768	512	96	48	192
7	NOx Binning / Fuel Consumption Tracking Subtotals				1 856			336
8	NOx Binning + Fuel Consumption Tracking							2 192 (890h)
9	512 byte Block Size effect 2 192 is 890h use A00h							2 560
10	Ring of 8 effect (Row 9 * 8)							20 480
11								
12	10 in 14 + 10 represents 5 GHG Active Technologies							

20K is more than ½ the 32K flash NVRAM block size planned for Near Term NXP chips (4, 32K blocks are provided)

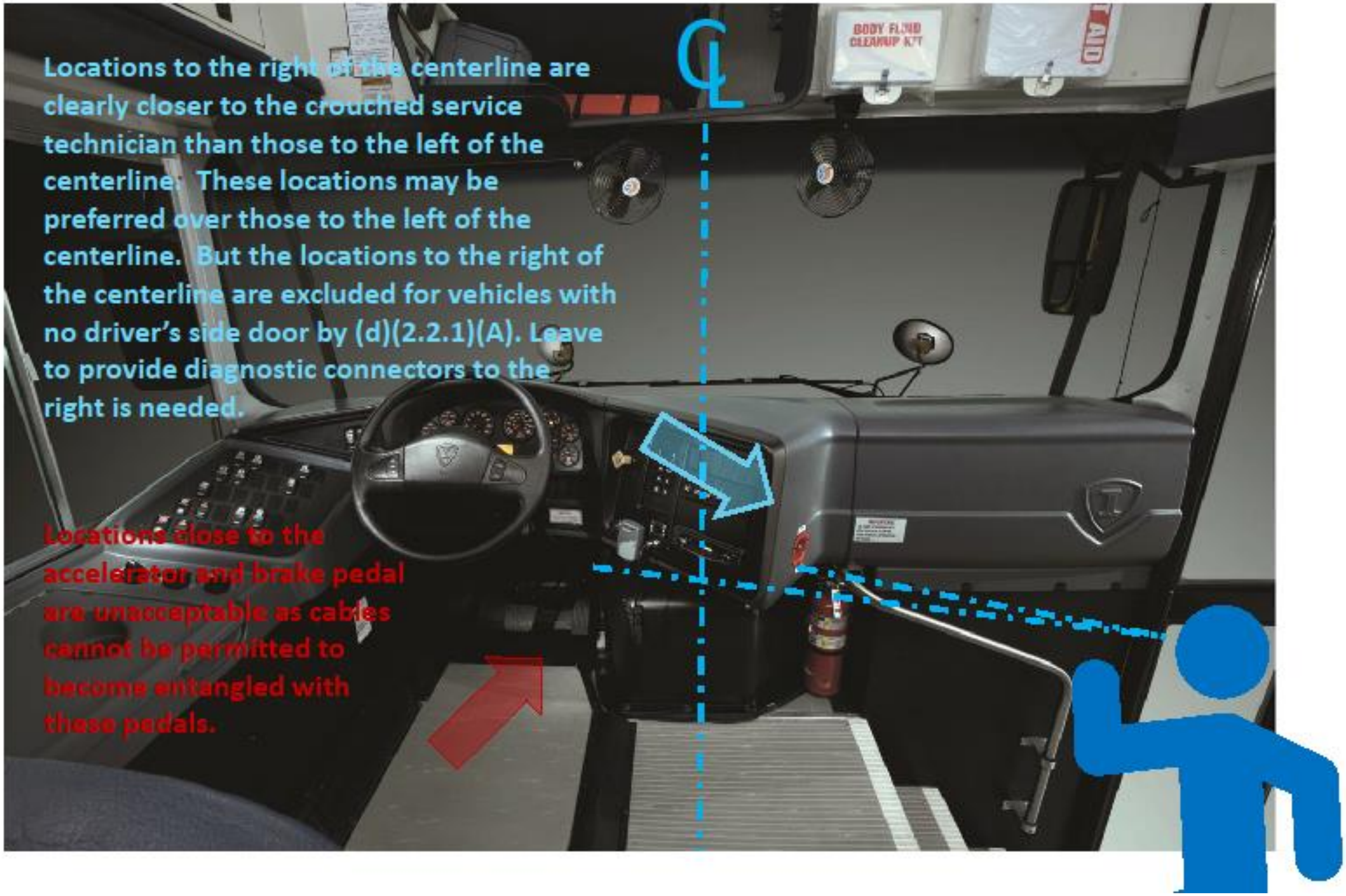
Table 4 NVRAM Memory Increase Using 4-byte 100 Hour Arrays (5 Engine Controlled Active Technologies)

Row		NOx Binning (h)(5.3.3)				Fuel Consumption Tracking (h)(5.4)		
		NOx Sensors Active			Engine Activity [Bin 1 is Σ]	Active 100h (5.7.2) (A)	Stored 100h (5.7.2) (B)	Lifetime (EA) (5.7.2) (C)
		Active 100h	Stored 100h	Lifetime				
1	Number of Bytes Per Element	4	4	4	4	4	4	4
2	Number of Elements per Parameter	16	16	16	16	1	1	1
3	Number of Parameters	6	6	6	4	14+10	14+10	14+10
4	Row 1 * Row 2 * Row 3	384	384	384	256	96	96	96
5	Intermediate Values Allowance (=Row 4)	384	0	384	256	96	0	96
6	Array Subtotals (Row 4 + Row 5)	768	384	768	512	192	96	192
7	NOx Binning / Fuel Consumption Tracking Subtotals				2816			3296
8	NOx Binning + Fuel Consumption Tracking							3 296 (CE0h)
9	512 byte Block Size effect 3 296 is CE0h use E00h							3 584
10	Ring of 8 effect (Row 9 * 8)							28 672
11								
12	10 in 14 + 10 represents 5 Fuel Consumption Active Technologies							

28K is more than ½ the 32K flash NVRAM block size planned for Near Term NXP chips (4, 32K blocks are provided)

\# # #

Exhibit F


Locations to the right of the centerline are clearly closer to the crouched service technician than those to the left of the centerline. These locations may be preferred over those to the left of the centerline. But the locations to the right of the centerline are excluded for vehicles with no driver's side door by (d)(2.2.1)(A). Leave to provide diagnostic connectors to the right is needed.
Locations close to the accelerator and brake pedal are unacceptable as cables cannot be permitted to become entangled with these pedals.