UNITED STATES OF AMERICA
ENVIRONMENTAL PROTECTION AGENCY

Clean Trucks Plan; Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards; Notice of Proposed Rulemaking	**)))))**	**Federal Register Notice: March 28, 2022** **Docket ID No.: EPA-HQ-OAR-2019-0055**

COMMENTS OF THE TRUCK AND ENGINE MANUFACTURERS ASSOCIATION

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1. Introduction

The Truck and Engine Manufacturers Association ("EMA") hereby submits its comments in response to the proposed Notice of Proposed Rulemaking ("NPRM") that the U.S. Environmental Protection Agency ("EPA" or the "Agency") published in the Federal Register on March 28, 2022 (see 87 FR 17414-17888) to establish next-tier low-NO_x emission standards and other related requirements for new heavy-duty on-highway ("HDOH") engines and vehicles. EMA represents the world's leading manufacturers of HDOH engines and vehicles. EMA appreciates the opportunity to submit these comments and supporting attachments.

In brief, the Agency is "co-proposing" two options –referred to as Option 1 and Option 2 – to dramatically reduce the emissions from new HDOH engines and vehicles, and to ensure that those reduced emissions are sustained throughout extended useful life and emission-warranty periods. Option 1, which is centered around a certification standard for NO_x of 0.020 g/bhp-hr, is more stringent than Option 2, which is centered around a NO_x certification standard of 0.050 g/bhp-hr. The respective details of the Agency's Option 1 and Option 2 proposals are summarized in the following table:

EPA Clean Trucks Plan NPRM Summary			Current	Clean Trucks Plan Option 1		Option 2
				2027	2031	2027
NOx	FTP and RMC	g/bhp-hr	0.20	0.035	0.020/HHDE: 0.040	0.050
	Low-Load Cycle (LLC)	g/bhp-hr	--	0.090	0.050/HHDE: 0.100	0.100
	Idle (voluntary)	g/hr	30 (CARB only)	5.0	5.0	10.0
	FEL Cap, FTP and RMC	g/bhp-hr	0.50	0.150	0.050 (HHDE 0.070)	0.150
PM	FTP, RMC, and LLC	g/bhp-hr	0.01	0.005	0.005	0.005
HC	FTP and RMC	g/bhp-hr	0.14	0.060	0.040	0.040
	LLC	g/bhp-hr	--	0.140	0.060	0.060
CO	FTP and RMC	g/bhp-hr	15.5	6.0	6.0	6.0
	LLC	g/bhp-hr	--	6.0	6.0	6.0
In-Use Conformity Factor (3B-MAW)			1.5 (NTE)	2.0	1.5	1.5
Useful Life	HHD		10y/435k/22khr	11y/600kmi/32khr	12y/800kmi/40khr	10y/650kmi
	MHD		10y/185kmi	11y/270kmi	12y/350kmi	10y/325kmi
	LHD		10y/110kmi	12y/190kmi	15y/270kmi	10y/250kmi
	SI HD		10y/110kmi	12y/155kmi	15y/200kmi	10y/150kmi
Warranty	HHD		5y/100kmi	7y/450kmi/22khr	10y/600kmi/30khr	5y/350kmi/17khr
	MHD		5y/100kmi	7y/220kmi/11khr	10y/280kmi/14khr	5y/150kmi/7khr
	LHD		5y/50kmi	7y/150kmi/7khr	10y/210kmi/10khr	5y/110kmi/5.5khr
	SI HD		5y/50kmi	7y/110kmi/6khr	10y/160kmi/8khr	5y/110kmi/5.5khr

It is important to highlight from the outset that while there are various details of EPA's rulemaking proposal (particularly with respect to Option 1) that EMA and its members fundamentally disagree with, there are multiple major points of substantial agreement. In that regard, EMA agrees with EPA that:

(i) The NO_x emission standards for HDOH vehicles should be reduced substantially starting in model year ("MY") 2027, perhaps by as much as 75% from the current standards;

(ii) The current NTE-based in-use testing protocols to assess the in-use emissions performance from HDOH engines and vehicles should be revised to cover all in-use operations and should, at least in part, incorporate a moving average window ("MAW")-based "binning" scheme for assessing those in-use emissions;

(iii) The current emission warranty and useful life periods for HDOH engines and vehicles should be revised to increase the durability and efficacy of in-use emissions compliance;

(iv) Most or all of the multiple aftertreatment components that the Southwest Research Institute ("SwRI") has configured and assessed in testing its "Stage 3" prototype engine systems should be utilized by OEMs to achieve optimal NO_x emission reductions from HDOH engines starting in MY 2027;

(v) A new low-load cycle and related emission standards should apply to the certification of HDOH engines starting in MY 2027; and

(vi) The proposed low-NO_x rulemaking should serve as a cost-effective bridge to the transition of HDOH trucks to zero-emission vehicles ("ZEVs") in as many applications as possible, and as soon as practical.

Accordingly, EMA supports the Agency's overall objectives to: "1) control emissions over a broader range of operating conditions; 2) maintain emissions control over a greater portion of an engine's operational life; and 3) provide manufacturers with flexibilities to meet the proposed standards." (87 FR at pp. 17420-21.)

In light of all of these major points of agreement, EMA is hopeful that the Agency's final rule will be consensus-based, highly cost-effective, and fully implementable starting with the 2027 MY. EMA also hopes that all stakeholders will take note of the multiple major points of agreement spelled out in these comments, and will not unduly focus on the finer points where EMA and its members have data-driven disagreements with the Agency regarding the technical feasibility of what the Agency has proposed, especially as pertains to Option 1. Again, notwithstanding those differing fact-based assessments of what is feasible at the margins of EPA's proposal, a consensus-based rulemaking should be achievable.

In that regard, EMA and its members acknowledge the significant ozone air quality attainment problems that still exist in several highly-populated areas of the country, and we recognize why EPA is seeking additional HDOH NO_x emission reductions and regulatory improvements. EMA's members are willing to develop and introduce advanced low-NO_x

technology solutions to effect very significant NO_x reductions, including through the types of "Stage 3" emission-control componentry being demonstrated at SwRI. Indeed, EMA encouraged prior Administrations to take the lead in proposing such next-tier low-NO_x regulations. EMA remains willing to collaborate on the finalization of an ambitious technology-forcing low-NO_x program that will yield substantial in-use NO_x reductions, while avoiding the unintended consequences of setting standards beyond the technical capabilities and compliance margins that frame what a cost-effective program should be.

Simply stated, EMA is fully committed to making this rulemaking a fully implementable success. All of EMA's subsequent more detailed comments are submitted in that spirit and with that aim.

In order to ensure the adoption of fully achievable and cost-effective HDOH low-NO_x regulations, and notwithstanding our broader agreement, the Agency should revise the proposed standards in the following manner:

(i) Any low-NO_x program that the Agency finalizes must be a one-step program with one set of new standards, not a multi-step program with increasingly stringent requirements. All stakeholders should recognize that one of the core objectives of this rulemaking is to establish a cost-effective "clean-diesel" bridge to a ZEV-truck future, which future will be mapped out, in part, through EPA's anticipated "Phase 3" GHG rulemaking, set to be proposed next year. The low-NO_x requirements of this rule should not spill over into the operative years of the envisioned Phase 3 rule. Otherwise, one of the unintended consequences of this low-NO_x rule will be to divert manufacturers' limited research and development resources away from the primary long-term goal of transitioning the commercial trucking industry to ZEVs.

(ii) The pending rulemaking — arguably the last rulemaking for HD diesel engines — needs to be truly cost-effective to ensure that the market is fully receptive to the new low-NO_x trucks. Otherwise fleet turnover will be stalled or delayed, which will diminish the envisioned benefits of the low-NO_x regulations. Fashioning a final rule that will not impede fleet turnover will help to ensure that the reasonably estimated benefits from this rulemaking can be achieved.

(iii) Manufacturers will not produce Option 1-compliant products because the Option 1 standards are not feasible. Accordingly, the FTP/RMC certification standards for NO_x must be set at Option 2-like levels, not 0.02 g/bhp-hr. Otherwise, the standards will fail to provide the requisite compliance margins, which will render them infeasible in practice, and will cause unacceptable compliance and recall risks for manufacturers. In addition, a program centered around Option 2-like levels will be more beneficial from an emissions-inventory perspective, once potential fleet turnover market responses, including pre-buy/no-buy responses, are taken into account.

(iv) The proposed extended useful life ("UL") requirements should be reduced sufficiently to ensure that manufacturers are not required to assume that they will need to replace aftertreatment systems during the extended UL periods, which necessary replacements would result in substantial and unreasonable cost increases for new HDOH engines and vehicles starting in the MY 2027.

(v) The proposed 3B-MAW in-use compliance protocol should be revised to ensure that a sufficient quantity of data is acquired for a robust compliance assessment without the need for multiple test-days. Later in these comments, EMA proposes an alternative to achieve this goal, while also guarding against additional potential infeasibility issues, especially those associated with the proposed medium/high load "Bin-3" standards.

(vi) The proposed in-use standards should be adjusted to account for the measurement variability and capabilities of portable emission measurement systems ("PEMS"), and to reflect the fact that the current OBD thresholds will not be able to screen-out potentially malfunctioning vehicles, as is done under the current in-use testing program. While EMA agrees with the Agency that the in-use standards should be reduced, the safeguards to ensure proper vehicle screening and to guard against "false" or otherwise unwarranted failures need to be retained.

(vii) As the Agency suggests in the NPRM, the final rule should include higher interim NO_x standards for a sufficient number of years to allow manufacturers to gain in-field experience with the additional emission-control technologies that will be required, and to gather real-world data to assess how those systems perform and age under real-world operating conditions out to the extended useful life periods. In that regard, higher interim NO_x standards to facilitate the implementation of the new stringent low-NO_x requirements (including, for example, through higher interim in-use multipliers) are distinct from the type of two-step progressively more stringent standards that EPA has included in Option 1. Those types of two-step emission standards raise fundamental feasibility and resource-constraint issues for manufacturers, including due to the potential need for additional engine hardware and software to comply with the second step, and ultimately would overlap and conflict with the Phase 3 GHG standards that EPA is beginning to develop.

(viii) The proposed low-NO_x program should be revised so that there is a better overall match of the program's costs and monetized health benefits, and, as noted, to guard against counter-productive pre-buy/no-buy market responses.

(ix) The current Phase 2 GHG standards should not be revised. The Phase 2 standards appropriately incentivized manufacturers to accelerate the deployment of ZEV trucks. Now, the Agency is proposing to tighten the Phase 2 standards solely because manufacturers deployed ZEVs as they were incentivized to do. That is fundamentally unfair. Manufacturers have relied on the stability of the Phase 2 provisions to formulate their product plans out to 2027 and beyond. When other stakeholders sought to undo the Agency's GHG standards, EMA and its members defended them. If, as the Agency is indicating, final rules really are not final, but are instead subject to unilateral revision by the Agency (in this instance because the rule's incentives worked!), the resulting precedent for undermining the regulatory certainty of "final rules" will yield very adverse consequences each time a new Administration takes office. The Agency should not open this type of Pandora's Box. No federal agency should feel unilaterally empowered to move the regulatory finish line well after the regulated industry's march toward compliance has begun.

EMA will address each of these important issues in detail in the technical comments and related expert reports discussed below. As already noted, EMA's comments are being submitted to facilitate the full and successful implementation of new HDOH emission standards, not to block that implementation.

2. Summary of EMA Comments

The Agency will need to fashion a final rule that can meet the broader goal at issue — to build a cost-effective and accessible regulatory bridge to a ZEV-truck future. To that end, the Agency will need to finalize just one set of HD low-NO_x standards to take effect in MY 2027, not multiple regulatory steps with multiple standards phasing-in through 2031 and beyond. Otherwise, the low-NO_x program for diesel engines will overlap with and undermine the implementation of the "Phase 3" GHG standards (which are slated to lead to the broader transition to ZEV trucks), and will divert OEM's inherently limited R&D resources to multiple iterations of diesel engine enhancements instead of focusing those resources on the needed advancements in HD ZEV technologies. All stakeholders recognize that diesel technologies will start to phase-out over the next decade. The scope and costs of this rulemaking need to account for and reflect that reality as well.

In that regard, and as an initial matter, EPA's proposed Option 1 proposal is fundamentally infeasible because, among other things, EPA has not and cannot fully demonstrate the feasibility of the Option 1 NO_x standards through testing with the "Stage 3" prototypes at SwRI, especially when adjustments for infrequent regeneration adjustment factors ("IRAFs") and other emission-impacting factors are accounted for. In particular, EPA has failed to demonstrate the feasibility of maintaining compliance with the Option 1 NO_x standards through the proposed extended useful life periods, and has not even completed the analysis of the Stage 3 protypes' emission results out to 800,000 miles. In addition, EPA has conducted no in-vehicle testing whatsoever, has not demonstrated that the Stage 3 prototype can meet the Option 1 NO_x standards while also meeting the current Phase 2 GHG requirements, and has done no testing to show that the Stage 3 prototype is capable of meeting the 2027 MY GHG standards. Indeed, in some testing, the CO_2 emissions from the Stage 3 prototype were up to 1.3% higher than the 2017 MY baseline engine. (87 FR at p. 17469)

Similarly, the Agency has not fully demonstrated the feasibility of the new proposed "in-use" bin-based low-NO_x testing and compliance protocols, particularly with respect to "Bin 3[1]," and, as noted, has not conducted any actual in-use testing with any prototype vehicles equipped with Stage 3 technologies. In that regard, EPA also has not adequately addressed the in-vehicle packaging requirements of the assumed low-NO_x technologies (e.g., cylinder deactivation and close-coupled multi-stream dual aftertreatment systems) in any prototype HDOH vehicle, nor has EPA assessed whether current engine control units (ECUs) and data-processing protocols can be

[1] Throughout these comments, the idle bin, the low-load bin, and the medium/high-load bin are alternatively referred to as "Bin 1", Bin 2", and "Bin 3."

upgraded and reconfigured to accommodate the very significant data-processing demands that are associated with EPA's "3B-MAW" proposal.

Equally important, the ultra-low level of EPA's proposed standards (if set based on a 0.02 g/bhp-hr FTP/RMC NO_x standard) would leave no room for any compliance margins that are necessary to account for production, fuel and emissions-testing variabilities, real-world operating conditions, or for the expected emissions deterioration over the proposed lengthened FULs of HDOH engines and vehicles. Simply stated, a program based on a 0.02 g/bhp-hr NO_x standard, as opposed to Option 2-like requirements, will leave no room for manufacturers to ensure and certify full in-use emissions compliance over the proposed extended useful life periods, and so is fundamentally infeasible. As a result, manufacturers cannot commit to building Option 1 compliant diesel engines. Stated differently, if EPA finalizes Option 1, the Agency will, in effect, prohibit HDOH diesel engines as of 2027. That would have enormous ramifications for the economy and security of this country.

In light of those core infeasibility issues, the inconsequential incremental NO_x emissions-inventory differences between a 0.02 g/bhp-hr-centric program and an Option 2-like program do not outweigh the risks of not being able to implement the type of viable comprehensive HDOH low-NO_x program that all stakeholders support.

Since the Agency's Option 1 proposal is not feasible, as detailed below, it necessarily follows that the more stringent "Alternative" concept is even more so. Accordingly, EMA fully agrees with the Agency that the Alternative alluded to in the NPRM is fundamentally unworkable and, as such, warrants no further discussion in these comments. Instead, EMA's comments will focus on the potentially implementable elements of Option 2, and, by comparison, the non-implementable elements of Option 1.

As noted above, a critical shortcoming of the Option 1 proposal, and to a certain extent the Option 2 proposal as well, is that the Agency has neither accounted nor provided for the compliance margins that manufacturers need to factor-in when designing and producing engine and aftertreatment systems capable of meeting the prescribed emission standards over the applicable useful life period. To the contrary, the "Stage 3" prototype systems that serve as the foundation for the NPRM just barely meet (or in some instances fail to meet) the new Option 1 NO_x standards over the new test cycles without any margin at all. The lack of allowing for sufficient compliance margins is especially evident from the emissions-test results of the aged Stage 3 systems, and has been specifically noted by SwRI as an area of concern. The Agency's failure to provide for the needed compliance margins must be remedied in the final rule.

Significantly, EPA acknowledges the fundamental importance of this issue, notwithstanding the Agency's failure to account for it. For example, EPA notes that, "to account for variability in emission measurements, as well as production variability, manufacturers typically add margin between the DF and infrequent regeneration adjustment factor (IRAF)-adjusted test result, and the family emission limit (FEL)." (87 FR at p. 17460.) Similarly, the Agency states that "manufacturers design their engines to perform significantly better than the standards when first sold to ensure that the emissions are below the standard throughout useful life, even as the emissions controls deteriorate." (87 FR at p. 17467.) The NPRM also acknowledges that "manufacturer margins can range from less than 25 percent to 100 percent of the FEL." (Id.) Finally, the Agency summarizes this critical issue, as follows:

> We understand that manufacturers generally aim to design and build vehicles not only with a sufficient margin to ensure the emissions control technology is meeting the applicable standards throughout the full useful life, but also an additional margin to reflect the fact that not every vehicle manufactured and every vehicle application will perform identically to the laboratory tests. This is particularly important, and challenging for manufacturers, when new technologies and test procedures are being implemented. (87 FR at p. 17564.)

Yet even with those express acknowledgements, the Agency did not attempt to quantify or provide for the compliance margins that manufacturers will need to meet NO_x standards that are 90 percent lower than today's standards. As explained more fully below, that failure completely undermines the feasibility of the Option 1 proposal, and will require revisions to the Option 2 proposal to make it fully implementable. Accordingly, EMA appreciates the Agency's request for comments on whether "a margin between the demonstrated emissions performance and the proposed standards should be included, and, if so, what that value should be." (87 FR at p. 17471.) EMA's comments specifically respond to that request, and quantify the necessary margins at issue.

Another of EMA's core concerns relates to the Agency's proposed new "3B-MAW" protocols and standards for assessing in-use compliance. Those in-use standards and protocols have not been developed simply to assess compliance with the underlying certification standards. To the contrary, the proposed 3B-MAW standards are, in effect, more stringent than the base certification standards, and will necessitate, among other things, larger catalyst volumes. That amounts to a fundamental paradigm shift in the scope and purpose of in-use testing. Heretofore, it was understood and agreed that in-use testing was a tool for assessing compliance with the corresponding initial certification standards, and was not intended to increase the stringency of those standards, or to compel additional emission-control technologies or hardware. That no longer will be the case under the 3B-MAW proposal. The Agency concedes as much:

> The proposed Option 1 in-use standard for the medium/high load bin [Bin 3] would likely require manufacturers to increase the volume of the SCR catalyst. We [also] project that the proposed off-cycle standards could be met through additional efforts to calibrate the duty-cycle technologies to function properly over the broader range of in-use conditions. We also recognize that manufacturers could choose to include additional technology. (87 FR at p. 17475.)

The paradigm shift at issue raises the stakes of the feasibility issues that the Agency has failed to adequately address. Those issues are especially pronounced with respect to the proposed Option 1 "Bin 3" standards. Indeed, out of the five in-use off-cycle drive cycles that SwRI ran using EPA's Stage 3 prototype, two of those cycles yielded results that either just met or failed to meet the Bin 3 standard, even after additional "re-calibration" efforts at SwRI.

The ramifications of the infeasible elements of the proposed off-cycle standards are further heightened due to the fact that the Agency is proposing to convert the in-use testing program into a de facto strict liability protocol. Currently, if a manufacturer "fails" what is referred to as the

"Phase 1" in-use testing of up to ten vehicles, then "Phase 2" testing is triggered, which can lead to a number of follow-up measures, but which does not automatically lead to engine recalls. That would change dramatically under the NPRM. More specifically, under the Agency's 3B-MAW proposal, "Phase 2" testing would be eliminated in its entirety, and compliance would be assessed solely on the basis of the in-use test results from up to ten engines. In other words, recall orders seemingly would follow automatically from what before would have been only the "Phase 1" testing. The Agency's truncation and conversion of the in-use testing protocols into a strict liability program augments the risks and costs of implementing what already are infeasible Option 1 standards, and likewise substantially augments the need for the robust compliance margins referenced above.

The Option 1 3B-MAW standards also are unrealistic because those in-use standards are at levels that essentially are equivalent to the emissions-detection capabilities of the latest portable emissions-measurement systems ("PEMS"), and an order-of-magnitude below the malfunction-detection capabilities of the latest on-board diagnostic ("OBD") sensors and systems. EPA's proposed low-NO_x regulations will rely on PEMS-based assessments and OBD sensor-based requirements to assure in-use compliance. But those systems cannot do so in a sufficiently reliable and consistent manner at the Option 1 NO_x levels at issue.

Even in an emissions laboratory, PEMS NO_x-detection technologies (based on non-dispersive ultraviolet ("NDUV") detection methods for NO and NO_2) have measurement "drift" that can be roughly equivalent to 20% of the proposed Option 1 in-use "Bin 3" NO_x standard of 0.03 g/bhp-hr, before taking any in-use operational and environmental factors into account. Those factors include imprecise exhaust and fuel-flow estimations, time-alignment issues, adverse ambient conditions and vibration, and PEMS-installation concerns.

EPA is proposing to address this issue by providing for a 10% measurement allowance (accuracy margin) based on an earlier European study that did not evaluate PEMS in the context of testing ultra-low-NO_x engines in-use. (87 FR at p. 17477.) Nevertheless, on the basis of that one earlier study, EPA is proposing to reduce the current in-use accuracy allowance margin for NO_x from 150 mg/bhp-hr to what amounts to 3 mg/bhp-hr with respect to the "Bin 3" standard – a 98% reduction. That is an unreasonable reduction. The accuracy of PEMS at low-NO_x levels certainly has improved, but not by 98%. EPA should wait for the results from the pending PEMS Measurement Allowance Study at SwRI before proposing, in effect, to eliminate the in-use accuracy margin for NO_x.

Similarly, today's OBD NO_x-sensor-based capabilities are insufficiently precise to detect in-use NO_x emission as EPA is proposing, or to assess in-use emissions compliance or potential emission-control malfunctions down at the proposed Option 1 levels. To the contrary, the current OBD NO_x-malfunction threshold is no lower than 0.40 g/bhp-hr. Tellingly, EPA is proposing to retain, not lower, that OBD NO_x malfunction threshold under the new low-NO_x regulations, implicitly recognizing that OBD NO_x sensors and related emission-detection systems are not accurate or robust enough to allow for the implementation of lower in-use OBD malfunction and enforcement thresholds. That is very significant because the higher OBD thresholds could allow emissions to far exceed the proposed in-use NO_x standards before detecting a fault or illuminating a MIL, which could increase manufacturers' potential in-use compliance risks, while, at the same time, reducing the benefits of the proposed emission standards by allowing potentially malfunctioning engines to operate without an indication of the need for emissions-related repairs.

In effect, then, EPA is proposing to maintain the NO_x-related OBD in-use compliance-assessment and enforcement criteria at a level that is an order of magnitude above the proposed applicable "3B-MAW"-based in-use NO_x emission standards. The net result is that EPA is proposing in-use low-NO_x standards (based on the Option 1 requirements) that could be below the ranges at which PEMS and OBD systems are able to accurately and consistently detect, measure or assess compliance with the proposed in-use NO_x standards. Similarly, EPA has not assessed whether ECUs have the data-processing capacity and capabilities to implement the proposed 3B-MAW program.

The proposed Option 1 requirements also likely would be cost-prohibitive, principally because of the incremental costs that would result from the proposed mandates for extended emissions warranty and full useful life ("FUL") periods. Those elements of the low-NO_x regulations will result in much higher warranty claims, maintenance costs, and recall liability, at least until the multiple new low-NO_x technology systems are proven-out over a multi-year period following the implementation of the 2027 MY standards and compliance programs. More specifically, the substantially extended warranty periods will at least triple the cost of coverage on existing emissions-related components, while also adding warranty costs to cover the new emissions-related components that manufacturers will need to utilize to meet the new standards. On top of that, the almost doubling of the FUL period over which compliance with the already infeasible NO_x standard would be required could force OEMs to include the cost of aftertreatment replacement as an assumed component of regular maintenance, while also leading to undue and unreasonable risks and costs stemming from potentially increased recall liability. Accordingly, and as confirmed by independent expert analyses and reports (see infra at Section 16 of these comments), it is expected that the monetized costs of a program centered around the Option 1 proposal would exceed the potential monetized health-related benefits.

The Agency asserts, without support, that the "proposed useful life periods are feasible and would not require manufacturers to adopt component replacement as a part of their critical emissions-related maintenance strategies." (87 FR at p. 17496.) We disagree. As an initial matter, EPA does not yet have the final analysis of the Stage 3 RW emission results at the 800,000 mile benchmark; nor has EPA shown that all of the Option 1 certification standards and Bin 3 standards are even feasible.

As a consequence, and given (i) the significant uncertainties regarding the durability and in-field performance of all of the new Stage 3 emission-system componentry over the extended useful life periods (up to 800,000 miles), (ii) the lack of the Stage 3 prototype's fully demonstrated compliance with the Option 1 standards, and (iii) the strict liability risks under the new 3B-MAW protocols, manufacturers likely will need to adopt aftertreatment component replacement strategies. The risks and costs of recalls, perhaps multiple recalls, would be too great for manufacturers to do otherwise.

One of the consequences of that reality is that the Option 1 proposal cannot be implemented in a cost-effective manner. In that regard, EPA's Regulatory Impact Analysis (RIA) has not factored-in manufacturers' anticipated costs of having to replace and pay for the multiple "Stage

3" catalyst systems. More specifically, at page 327 of the RIA, EPA concedes that its cost estimates – unlike the detailed cost analyses prepared by Ricardo and the National Renewable Energy Laboratory (NREL) (discussed infra) – do not include a scheduled replacement of the new envisioned multi-component aftertreatment systems, notwithstanding that EPA's proposal will, in effect, extend the useful life requirements for those systems out to 650,000 miles or even to 800,000 miles, for HHD engines. On that point, EPA states as follows:

> Our understanding is that, while the costs associated with warranty and useful life are quite high [in the NREL study], they were estimates associated with complete system replacement at some point during the extended useful life of the engine/vehicle. *We have assumed* that manufacturers would not pursue such an approach and would, instead, include upfront (i.e., at the point of end user purchase) [sic] with the expectation that the parts would last the full useful life without a mandatory replacement. For that reason, we have chosen not to use the warranty and useful life cost estimates presented by NREL [or by Ricardo], and have instead used [our own] approach. (RIA, p. 327.) (Emphasis added.)

EPA's assumption in that regard is neither reasonable nor correct. HDOH engine and vehicle manufacturers have expressly and repeatedly informed EPA that they will be compelled to include a replacement of aftertreatment systems in their design and cost calculations to ensure that low-NO_x emissions performance can remain stable and compliant out to the significantly extended useful life periods. EPA's decision to disregard the information provided by manufacturers has led to the Agency's inaccurate estimates of the overall costs of its proposal. On that point, the Agency likely has underestimated costs by an order of magnitude. For example, while EPA estimates that the per-vehicle incremental cost of its Option 1 proposal will amount to approximately $4,000 for HD vehicles (see 87 FR at p. 17571, Tables V-10 and V-11; RIA, p. 329, Tables 7-19 and 7-20), Ricardo's cost estimate, in line with NREL's, is that those per-vehicle incremental costs will be closer to $42,000, including increased operating costs. The net result is that EPA's proposal, as it stands, is not based on sound assumptions and is not cost-effective.

Notwithstanding the foregoing, EPA claims that extending the useful life and warranty periods as proposed actually will lead to lower costs, and that the Option 1 proposal, even though more stringent than Option 2, will be less costly than Option 2 because the shorter Option 2 warranties will result in higher net emissions-related repair costs than under the Option 1 proposal. (87 FR at p. 17428.) That too is not correct. It assumes, incorrectly, that engine and vehicle manufacturers would not fully account for their increased emissions-related repair obligations under Option 1's extended useful life and warranty requirements in setting their increased purchase prices for Option 1-compliant products. In fact, EPA itself has rebutted that assumption: "Manufacturers include warranty repairs in the price of an engine or vehicle." (87 FR at p. 17511.)

Given all the significant issues and concerns regarding EPA's Option 1 proposal, EMA appreciates that EPA is still "considering the degree to which there is uncertainty in how the [Stage 3] technologies deteriorate when the engine is installed in a wide variety of heavy-duty vehicle applications that exist in the marketplace, and how to address such uncertainty." (87 FR at p. 17563.) In that regard, EMA agrees that the feasibility issues and related uncertainties are significant, and we fully support the Agency's suggestion that higher interim NO_x standards may be warranted, perhaps extending out for five or more MYs, to allow manufacturers "to gain experience with the additional [Stage 3] emission control technologies needed to meet the proposed NO_x standards while these technologies are operating in the field." (Id.) Thus, and as detailed further below, EMA strongly agrees that the Agency should include in the final rule "interim in-use standards to account for uncertainties about potential variabilities in performance during the early years of implementing new technology." (87 FR at p. 17564.)

With respect to the proposed "reopening" of the current Phase 2 GHG standards, specifically the standards set to take effect in MY 2027, the Agency simply should not do that. OEMs have relied on the certainty of those progressively more stringent GHG standards in designing their engine platforms and vehicle upgrades, and in accelerating their deployment of ZEV trucks where feasible. Indeed, the Agency sought to incentivize that accelerated deployment of ZEV trucks by providing for enhanced emission credits.

But now, really for no other reason than the incentives worked to encourage the manufacture and sale of ZEV trucks in certain applications, the Agency is proposing to tighten the Phase 2 GHG standards by 1.5% in 2027, to, in effect, take back the credits that led to the intended increased deployment of ZEV trucks in the first place. It is the type of blatant renege that would never be allowed in commerce, and it should not be a practice of the federal government.

The Agency's proposed undoing of its prior regulatory commitments is even more egregious in this case since, unlike other stakeholders in other regulated sectors, EMA and its members defended and sought to preserve the Phase 2 standards when the prior Administration was looking to reduce those standards across the board. Yet now the Agency is poised to engage in the same type of activity — re-trading previously-adopted emission standards — that environmental advocates bemoaned only a few years ago.

If the Agency persists in moving the regulatory goalposts after the underlying rules were set and OEMs' compliance efforts were well underway, the precedent will not be lost on anyone. Henceforth, all "final" regulations will be deemed open to fresh debate and revision anytime a new Administration is sworn-in. Not all of those revisions will trend in the same direction. Stated differently, if the Agency insists on eliminating the assurances that heretofore accompanied final rules, that same lack of assurance is just as likely to burden the Agency in the future. The Agency should not include Phase 2 revisions in this low-NO_x rule, but instead should leave the development of enhanced GHG requirements to the imminent "Phase 3" rulemaking that is earmarked for that specific purpose.

EMA's comments will provide detailed data and analysis in support of each of the foregoing points, and will highlight multiple other infeasible aspects of the Agency's Option 1 proposal. In brief, the multiple points of concern regarding the Agency's proposal, particularly with respect to Option 1, include the following:

(i) The feasibility of centering a program around a 0.02 g/bhp-hr FTP/RMC NO_x standard (as opposed to a core standard set at or above Option 2-like levels) has not been and cannot be established.

(ii) EPA has not sufficiently validated the new proposed in-use low-NO_x standards and "3B-MAW" testing protocols, particularly those associated with "Bin 3."

(iii) EPA's proposed in-use low-NO_x standards need to properly account for the capabilities of in-use emission-measurement and data-processing systems.

(iv) The low-NO_x regulations, if centered around a 0.02g/bhp-hr standard, could result in decreased fuel-efficiency, which could threaten the feasibility and implementation of the HDOH Phase 2 GHG standards, especially the 2027 MY standards, which standards should not be revised.

(v) The proposed extended UL and durability demonstration testing requirements, coupled with the increased recall liability, could result in manufacturers building-in assumptions regarding the need to replace the aftertreatment systems at approximately 500,000 miles (or sooner), which would cause substantial price increases for new HDOH vehicles.

(vi) The increase in manufacturers' costs to cover the proposed extended warranty requirements will be substantial, and necessarily will be passed on to purchasers at the point of sale.

(vii) A nationwide program centered around Option 2-like requirements, and including higher interim in-use standards, would be more cost-effective, and would reduce the prospects for further delaying fleet turnover or creating disruptive pre-buy/no-buy responses from the market.

(viii) There are a number of inaccuracies in EPA's Cost Assessment, Standardized Regulatory Impact Analysis, and Environmental Analyses that need to be addressed.

(ix) The low-NO_x regulations, if centered around Option 1, would have costs that exceed monetized benefits by a significant margin, as demonstrated through independent expert analyses prepared by Ricardo, NERA Economic Consulting, ACT Research Group, and NREL.

EPA must address each of these issues in order to finalize a fully implementable and cost-effective low-NO_x program. EMA stands ready to assist in those necessary follow-on discussions to ensure the adoption and implementation of a stringent cost-effective low-NO_x program. In that regard, EMA believes that a modified Option 2-based program could be implemented in a fully cost-effective manner.

3. <u>The Relevant Legal Standard</u>

Section 202 of the federal Clean Air Act ("CAA"), 42 U.S.C. §7521, governs the Agency's establishment of emission standards for new mobile sources, including HDOH engines and vehicles. CAA section 202(a)(3)(B) specifically governs the Agency's establishment of "revised standards for heavy-duty trucks." Unlike the general standard-setting provisions contained in section 202(a)(3)(A) – which call for the establishment of emission standards that "reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply" – section 202(a)(3)(B), the specific provision that applies here, simply states that the Administrator may set revised emissions standards "taking costs into account."

Consequently, in assessing the details for the proposed revised low-NO_x regulations at issue, costs, not the absolute limits of potential technological feasibility, are a paramount consideration. In this case, a full and fair consideration of costs and benefits leads to the conclusion that a low-NO_x program centered around an Option 2-like program will yield an optimized final rule, while a program centered around the Option 1 proposal is simply not workable.

4. The Proposed Option 1 NO_x Standard and Related Requirements Are Not Technologically Feasible

EMA has multiple concerns with the capabilities of the Stage 3 prototype systems to consistently achieve NO_x results compliant with the Option 1 proposal. EMA similarly has concerns regarding manufacturers' ability to design, produce and deliver similar prototype engines and aftertreatment systems capable of meeting all of the Option 1 requirements over the extended useful life and emission warranty periods at issue. Indeed, the Option 1 standards are not feasible.

Broadly speaking, EPA's assumption that its proposed Option 1 standards and requirements are fully feasible is a fallacy. Moreover, that fallacy is premised on only one set of data — in some instances just one data point — from one still-evolving prototype engine used in one not-fully-successful experiment. That is the sum and substance of the basis for EPA's incorrect assumption that manufacturers can design and build engine systems to meet a NO_x standard starting at 0.02 g/bhp-hr, and ending at 0.04 g/bhp-hr at the 800,000 mile mark, without the need to replace any emissions-related components. As explained in great detail below, a rulemaking of this magnitude based on such scant data and such fallacious assumptions will not stand. Instead, an Option 2-like program will need to serve as the foundation for a sustainable final rule.

a. Background and summary of technical infeasibility concerns

By way of background, it is important to understand the rigor of the current HDOH NO_x standards. To comply with EPA and CARB's "US10" heavy-duty emissions standards, HDOH diesel engine manufacturers have deployed elaborate exhaust aftertreatment systems supported by complex control strategies downstream of advanced NO_x-reducing exhaust gas recirculation ("EGR") systems, which were introduced earlier to meet the prior "US04" emissions-reduction step. Wall-flow diesel particulate filters ("DPF") were introduced in 2007 to meet the 0.01 g/bhp-hr particulate matter ("PM") standard. Those DPFs have required either a "7th" diesel fuel injector or in-cylinder dosing to periodically inject fuel into the exhaust stream over a diesel oxidation catalyst ("DOC"), elevating exhaust temperatures to oxidize soot that accumulates on the filter. By 2013, all major HDOH diesel engine manufacturers also had deployed Selective Catalytic Reduction ("SCR") systems with an ammonia slip catalyst ("ASC") downstream of the DPF to meet the fully-implemented US10 NO_x standard of 0.20 g/bhp-hr. SCR systems require Diesel Exhaust Fluid ("DEF") stored on-board (and replenished at approximately every second refueling event), which is injected at carefully controlled rates, dynamically adjusted in response to operating parameters and ambient conditions.

Despite the fact that the NO_x conversion efficiency of SCR varies with exhaust temperatures commonly encountered during HD diesel vehicle operation, comprehensive testing by West Virginia University ("WVU") of 100 HDOH diesel vehicles in various highway and vocational applications operating in Southern California has demonstrated that US10-compliant emissions-control systems reduce total NO_x emissions from in-use vehicles at levels proportional to the change in the certification standards. DPFs are even more effective, reducing PM emissions to a fraction of the certification standard. Overall, NO_x emissions from HD diesel vehicles compared to pre-regulation levels have been reduced by some 98%, and PM emissions by 99%.

CARB's recently promulgated Omnibus low-NO_x regulations include a NO_x standard reduced by another 90% from the US10 limit, and another 50% reduction in the PM mass standard. The PM reduction is intended primarily to serve as a backstop against the potential adoption of less effective DPF designs than the current ceramic wall-flow systems capable of performing well below the US10 limit. The additional 90% NO_x reduction, however, especially when coupled with a new "low-load" certification cycle, and a completely new in-use emissions testing and compliance protocol (with barely measurable NO_x limits), presents an inherently infeasible technical challenge for HDOH diesel engines. It should be noted that these aggressive targets are actions to reduce the last 1 to 2% of NO_x emissions from these engines. EPA's proposed "Option 1" mirrors the CARB Omnibus requirements in almost every respect, including a 0.020 g/bhp-hr NO_x certification standard proposed to be effective in MY 2031.

Throughout the rulemaking process for the Omnibus low-NO_x regulations, CARB asserted that its new low-NO_x requirements are technically feasible. The primary basis for CARB's assertion, like EPA's here, is the technology demonstration effort undertaken by Southwest Research Institute ("SwRI"). CARB contracted with SwRI to develop a diesel engine and aftertreatment prototype capable of meeting a 0.020 g/bhp-hr NO_x certification standard when aged to the equivalent of 435,000 miles of operation. The 435,000 mile threshold is the current US10 heavy heavy-duty Useful Life requirement (CARB's rule extends that Useful Life requirement to 800,000 miles, but with a doubling of the NO_x standard (to 0.04 g/bhp-hr) for the interval from 435,000 miles to 800,000 miles). SwRI modeled a variety of combinations of aftertreatment components, coupled with engine improvements intended to elevate exhaust temperatures, and ultimately focused on what came to be known as the "Stage 3" technology package for the 435,000 mile-aged emissions demonstration prototype.

To support its low-NO_x rulemaking, EPA also contracted with SwRI to perform an aged emissions demonstration with a technical solution very similar to the CARB "Stage 3" technology package. Thus, the laboratory experiment that SwRI has run on the "Stage 3" prototype is the sole source of actual emissions data supporting EPA's assertion regarding the purported feasibility of the 0.020 g/bhp-hr NO_x standard. In some instances, that support amounts to a single data point.

EMA has been engaging with EPA and CARB from the outset on these HDOH low-NO_x rulemakings, including the underlying SwRI demonstration program. Our conclusion is that the Omnibus/Option 1 low-NO_x standards have **not** been demonstrated to be technically feasible, and are in fact infeasible, for the following reasons:

1) The aged-engine “Stage 3” NO_x emissions results do not meet the proposed future 0.020 g/bhp-hr NO_x standard across all required certification cycles, nor do they consistently meet the in-use NO_x standards when laboratory tested using “road cycles” that mimic real-world operation (which, practically speaking, makes the case that the SwRI program was a demonstration of technical *in*feasibility.)

2) CARB and EPA have not considered the impacts of the real-world conditions and other factors that increase NO_x emissions, or the accelerated aftertreatment deterioration that will occur in the field, all factors for which diesel engine manufacturers will be held accountable. Those real-world conditions and other factors, which were not “in scope” in the SwRI demonstration program, will require significant additional development effort, and likely additional NO_x and CO_2 emissions control hardware. “Getting close” to meeting extremely stringent emissions requirements, which is all that SwRI has done, is inadequate and unreasonable as a basis for setting the Option 1 emissions standards at issue, especially when critical and significant emissions-increasing factors have not been considered.

3) With each successive regulated emissions-reduction step, diesel engine manufacturers have been compelled to engineer emissions control systems capable of withstanding the multiple real-world emissions-impacting factors, factors which have played a progressively more important role as standards have been reduced. The growing importance of these real-world factors – which require manufacturers to design for significant compliance margins – is clearly evidenced from the trends observed in manufacturer certification test results as NO_x standards have decreased steadily over the last 25 years.[2] The need for significant compliance margins is further established by the fact that, despite manufacturers’ certification results being, on average, well below the current 0.20 g/bhp-hr NO_x standard, not one manufacturer had certified a HD diesel engine family to generate NO_x credits until model year 2022, and in that case, even higher than average margins were provided for.

4) The “Stage 3” technical solutions used as the basis for the EPA and CARB rulemakings include technologies such as individually-controlled cylinder deactivation systems that have never-before been used on HDOH production engines subject to the durability requirements of the medium heavy- (“MHD”) or heavy heavy-duty (“HHD”) diesel engine markets, and that also require an unknown scale of effort to address the “noise, vibration and harshness” (NVH) challenges that arise in the context of the multiple custom-tailored vehicle specifications of HD trucks.

5) “Packaging” requirements (i.e., fitting emission systems under the hood or cab) to “close-couple” the new light-off SCR (“LO-SCR”) to the turbocharger turbine exit will be extremely difficult, and/or will require cab retooling. Such retooling costs come at a very high cost (on the order of $500M) for low-volume products with potentially abbreviated amortization schedules, especially as those same vehicles transition to battery-electric and other “zero-emissions” technologies driven, at least in part, by other regulations. EPA has done nothing to assess the feasibility of the multiple packaging challenges at issue.

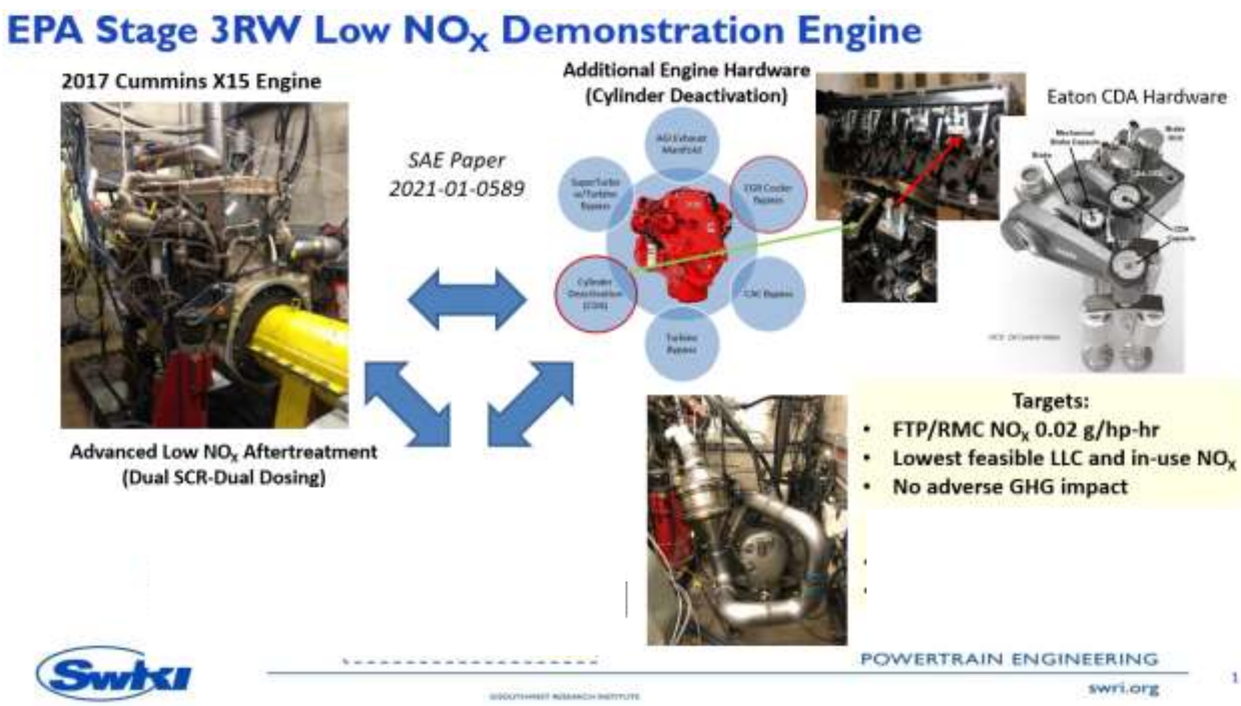
[2] A similar trend of drastically increased compliance margins has been observed on non-road heavy-duty variable speed diesel engines as well, averaging 9% with Tier 3 designs, and 50 to 62% (depending on the test cycles) with Tier 4 Final designs.

6) Heavy-duty diesel engines also are regulated to control CO_2 emissions. The "Stage 3" technical solutions for NO_x have not been demonstrated in combination with the requisite improvements that will be needed to comply with the 2027 CO_2 emissions standards. The Stage 3 engine does not even meet the 2021 or 2024 CO_2 standards, for that matter. The well-established NO_x/CO_2 tradeoff that has challenged diesel engine manufacturers for decades has not been given adequate consideration in EPA's Option 1 proposal.

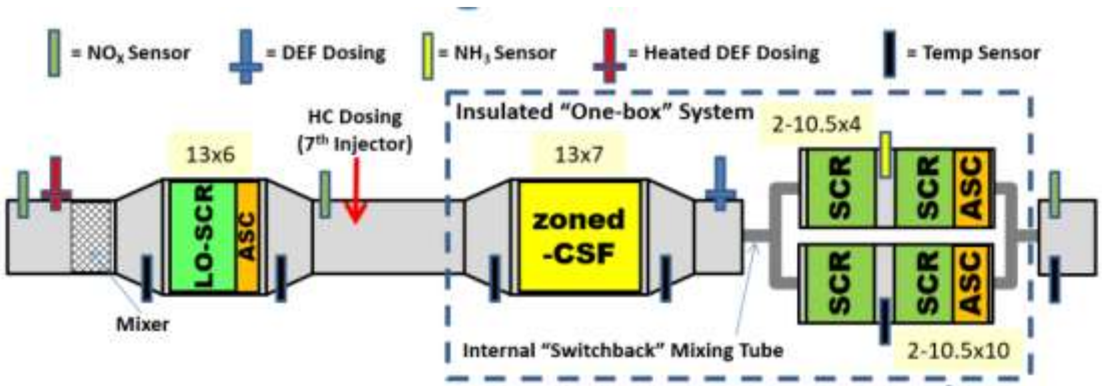
The remainder of this section will explain each of the foregoing points in greater detail.

b. Description of the "Stage 3" technical solution that EPA relies on as the basis for its technical feasibility determinations

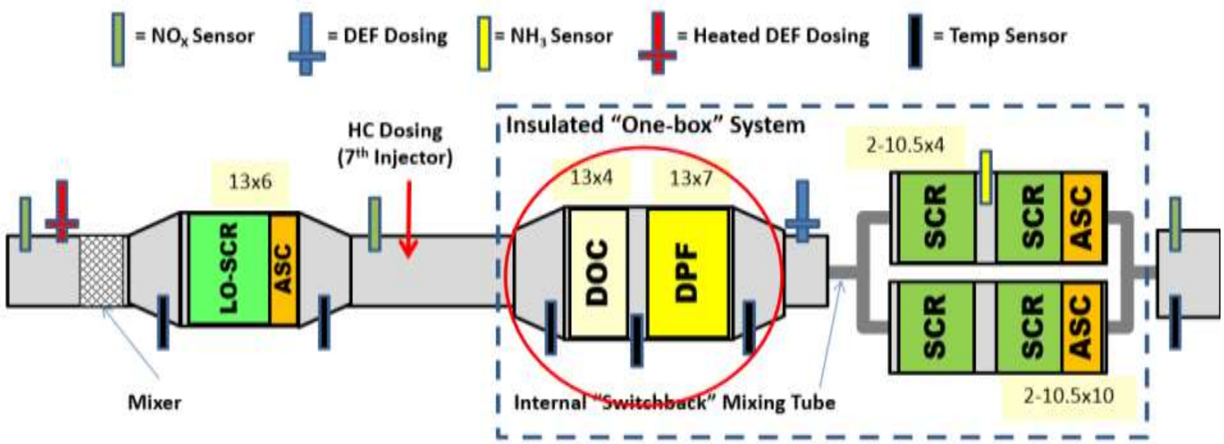
As noted, the SwRI demonstration project is the source of the data behind EPA's assumption that the low-NO_x standards at issue are feasible for HDOH diesel engines. SwRI conducted baseline tests of a production configuration 15L Cummins HD diesel engine calibrated for certification to the US10 HDOH emission standards. SwRI outfitted the engine and its aftertreatment system with additional emissions control systems for the purpose of the demonstration project. Features of the "Stage 3" solution include cylinder deactivation (CDA) to increase light-load exhaust temperatures, and an EGR cooler bypass, as depicted below:



The aftertreatment system that CARB used in its low-NO_x demonstration added several new components to the US10 DOC/DPF/SCR/ASC configuration, including a second SCR catalyst closely coupled to the turbocharger outlet (a light-off SCR, or "LO-SCR") with its own independent *heated* DEF injector, a zone-coated soot filter ("zCSF"), and other refinements intended to improve DEF mixing in the downstream SCR. A third NO_x sensor was added after the LO-SCR to calculate and activate DEF dosing rates for the downstream SCR, and an NH_3 sensor was installed at the midpoint of the downstream SCR bricks to monitor and correct those dosing rates. Thermal management routines were structured to optimize cold-start and light load emissions control. A diagram of the CARB Stage 3 prototype aftertreatment system is included here:



EPA is using the SwRI-developed Stage 3 solution as the backbone of its own technical feasibility demonstration, but with one primary modification. EPA's technical solution (which SwRI calls the Stage 3 Reworked system, or "Stage 3 RW") uses a conventional DOC/DPF rather than a zCSF to improve regeneration robustness and to sustain more consistent NO-NO_2oxidation over time. The EPA Stage 3 RW system also includes minor sizing and control calibration differences compared to the CARB Stage 3 solution, but otherwise the technical packages are very similar. A schematic of the "RW" aftertreatment system is shown here:



c. There are several technical risks associated with the "Stage 3" low-NO_x technology package

i. CDA-related issues

One of the key enabling technologies in the Stage 3 prototype's suite of engine and aftertreatment solutions is cylinder deactivation ("CDA"). CDA permits an engine to selectively deactivate certain cylinders from the combustion process, thereby meeting the power demand with fewer cylinders in operation, which in turn elevates exhaust temperatures while decreasing CO_2 emissions.

A critical challenge for manufacturers, however, is to implement CDA on a heavy-duty diesel engine, and have it deliver consistent, reliable, durable performance over 800,000 miles, without creating truck and cab "noise, vibration, and harshness" ("NVH") issues or driveline torsional problems. Implementing CDA with individual independent cylinder deactivation control has never been achieved before on MHD or HHD diesel engines,[3] but this technology is a fundamental element of EPA's attempted technical feasibility demonstration, applicable to every HDOH diesel engine sold in the US from and after 2027.

It is instructive first to consider the design aspects of CDA. CDA is not a bolt-on, one-size-fits-all system that an OEM can purchase off-the-shelf from a component supplier. Each diesel HDOH engine valvetrain design will require a unique CDA design integration. CDA also will introduce new and potentially catastrophic failure modes, such as failures to open the exhaust valve on the exhaust stroke of a firing cylinder, and subsequent intake valve and valvetrain failures as the intake valve attempts to open under extremely high pressures.

In addition, CDA presents complex challenges for the multiple applicable HD OBD requirements, strategies and calibrations. OBD threshold diagnostic determinations become very difficult when CDA is factored-in, since multiple valves individually or in concert may experience either partial or complete failures. In such a case, separate failure modes would require separate diagnostic validation for each failure mode permutation. The OBD challenges would not be limited to diagnostics of the CDA system itself. CDA can significantly alter the required strategies and calibrations of multiple system diagnostics. For example, CDA greatly complicates the ability to diagnose misfire, a detection issue that already is among the more challenging under the HD OBD regulations.

Another major concern associated with CDA, as mentioned above, relates to NVH. The in-line six-cylinder engine configuration that dominates the HDOH diesel engine market has inherent torsional balance advantages over other configurations. When individual cylinders are deactivated, that natural torsional and harmonic balance is disturbed, so the engine vibration levels are increased and torsionals in the engine and driveline systems are elevated. The result is increased noise levels and cab vibration levels that can be uncomfortable to the driver, and that can cause increased wear and stress on cranktrain and drivetrain components, and vibration levels throughout the vehicle that can cause performance and fatigue issues for on-board systems.

[3] One manufacturer of heavy heavy-duty engines has industrialized a system capable of deactivating all three front cylinders as a group (without individual cylinder control).

While SwRI performed some computer-based modeling to assess possible cylinder deactivation combination schemes to reduce simulated vibration as assessed in the test cell, there is a vast difference between vibration characteristics "as modeled" in an emissions laboratory, and those experienced in an actual HD vehicle on the road. That fact was duly noted by Neely, et al., of SwRI in their related SAE article, where they stated, "Acceptability standards to linear vibration (e.g. measured at the seat, steering wheel, foot pedal, frame rails, etc.) are better understood in a vehicle environment. The system driveline in a vehicle will differ from that in a dyno (test cell) as well, and it is recommended to evaluate driveline response in a typical vehicle setting."[4] EPA and SwRI have not done that.

Indeed, one OEM's experience with a prototype CDA system in a Class 8 vehicle has found that, at the lowest loads and speeds, drivers' responses to the experienced NVH issues are not favorable, especially when the minimum number of cylinders are active. Depending on the extent of CDA at a given load and speed, NVH can vary from mildly perceptible to very significant and fatiguing. The concern for manufacturers and fleet operators then becomes whether CDA would adversely impact driver attentiveness, fatigue, and, ultimately, driver retention. While increasing the number of active cylinders and engine speed can result in a more positive driver response, that reduces the benefits derived from the elevated temperature of CDA. Passive or active engine mounts can help improve those negative responses, but there is insufficient data on the broad range of truck powertrain configurations to know whether those issues can be addressed in a sufficiently effective manner.

Manufacturers of Class 2b-3 vehicles (14,000 lbs. and less), where gasoline engines of smaller displacements have been fitted with CDA, are very familiar with the magnitude of the engineering challenges to overcome NVH issues. Each engine installation on each unique vehicle model is its own development project, requiring significant resources, multiple technical solutions, and substantial verification time. The technical solution, depending on the vehicle model, can include engine-mount tuning, active noise-cancellation systems, exhaust butterfly valves and pipe geometry modifications, active-tuned dampers, and high-torque-convertor slip settings. HDOH diesel vehicle and engine manufacturers do not have a sufficient body of knowledge regarding the range of heavy-duty truck powertrain configurations to know how effective those potential technical solutions might (or might not) be in larger engines and vehicles. Moreover, some of those solutions will have negative fuel efficiency impacts.

As noted, the CDA engineering challenge is multiplied in this case by the fact that each CDA installation requires an engineering investigation and a unique combination of solutions. Given the multiple significant differences among heavy-duty truck configurations and applications, the resultant number of those technical challenges could be insurmountable. When the level of customization that occurs with each customer's purchase in the HD vehicle market is taken into account, the level of effort, resources and time it could take to implement CDA effectively could quickly become overwhelming.

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[4] *Simultaneous NO_x and CO_2 Reduction for Meeting Future California Air Resources Board Standards Using a Heavy-Duty Diesel Cylinder Deactivation-NVH Strategy*, Neely et al., Southwest Research Institute, SAE article 03-13-02-0014.

ii. Light-off SCR (LO-SCR)-related issues

The addition of a LO-SCR system is another key component of the Stage 3 RW aftertreatment control strategy, although one manufacturer evaluating its benefits is finding that the extra catalyst mass of the LO-SCR is increasing hot FTP results, to the point of increasing the composite FTP results.

A LO-SCR will be subjected not only to fuel-based contaminants such as metals commonly found in the biofuels promoted by EPA and CARB, but also oil poisoning will occur at a rate higher than experienced by today's SCR systems (which benefit from the protection of an upstream DPF). Oil-derived contaminants are known to deposit heavily on the first catalyst brick encountered in the aftertreatment array, which acts to delay catalyst light-off under cold conditions and light load.[5] Oil-derived poisonings are not reversible under any engine-based regeneration strategy, and they also can act to reduce the catalyst channel size. More desulfation activity will be required than today because the LO-SCR will not benefit from the elevated thermal conditions that now will be associated with *downstream* DPF regeneration events. Moreover, the interaction of DEF deposits with oil deposits is unknown (particularly under cold-start, and low-load operation), but may lead to a further reduction of the catalyst channel size, leading to increased backpressure and associated CO_2 penalties.[6] EMA is working with the Coordinating Research Council (CRC) to measure tailpipe emissions impacts when the Stage 3 system is run with a range of market-available fuels and biofuels. The results of that study should be considered before the Agency finalizes this rulemaking.

Further complicating the issues associated with the LO-SCR system are packaging requirements. To be effective, the LO-SCR system must be "close-coupled" to the turbocharger turbine exit. In some cases, and especially with the smaller range of vehicles in the HD class, packaging constraints will be extremely difficult to overcome. Cab retooling will be necessary in some cases, as efforts to adequately insulate long runs of exhaust piping will compromise the efficacy of the LO-SCR unit. Cab retooling costs can be very high (as much as $500M), particularly for low-volume products with potentially abbreviated amortization schedules, since those same vehicles will be transitioning to battery-electric and other "zero-emissions" technologies due, at least in part, to additional anticipated GHG regulations and zero-emissions vehicle sales and purchase mandates.

An examination of packaging challenges on a single vehicle model as performed by one manufacturer has determined that the "hot side" of the engine compartment will require a complete redesign. With the LO-SCR being larger than the traditional downpipe, additional heat shielding will be required to protect proximate components. That is particularly problematic since the proximate components include much of the HVAC hardware, such as heater/evaporator coils, fan air intake and similar, as well as electrical junctions, fuse panel, PCM, relays and other temperature

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[5] See *A Case Study of a CuSSZ-13-SCR Catalyst Poisoned by Real-World High Sulfur Diesel Fuel*, Yuanzhou Xi (Cummins) et al, SAE 2020-01-1319, April 14, 2020.

[6] That poisoning effect would be exacerbated by the "thin wall, high-cell density" substrates proposed as a potential low-NO_x technology solution by the Manufacturers of Emissions Controls Association (MECA). Oil poisoning is linear with exposure. In that regard, the accelerated catalyst aging demonstration performed at SwRI exposed the catalyst to only 1/3 of the expected "intermediate UL" (435k mile) oil quantities. No consideration was given to the level of oil exposure expected under the proposed extended FUL of 800k miles (nearly double). That is an inadequate demonstration of the durability of the close-coupled SCR due to oil-derived poisoning.

sensitive components. Those thermal issues are exacerbated by the transition to low-GHG HVAC refrigerant HFO 1234yf, where there are additional flammability concerns. Adding length or height to the vehicle hood to "make room" to mitigate the packaging challenges will compromise bumper-to-back of cab limitations, or will increase GHG emissions due to increased aerodynamic drag, or both. Reducing the substrate frontal area to improve packaging will increase backpressure and CO_2 emissions. None of these challenges has an obvious solution.

iii. NO_x sensor issues

Major improvements in the accuracy of NO_x sensors are not foreseen in the timeframe of the proposed low-NO_x standards. NO_x sensors (three of them are used in the Stage 3 solutions) play a critical role in DEF dosing strategies and long-term trim functions. In addition, the NH_3 sensor used to monitor ammonia levels for the mid-SCR catalyst bed is known to be highly inaccurate. EMA is working with SwRI to conduct tailpipe NO_x sensitivity tests on the Stage 3 RW configuration in response to the installation of NO_x and NH_3 sensors with measurement bias representative of field-aged sensors. EMA is seeking to quantify with real data the tailpipe NO_x impacts from those (and other) sensor inaccuracies. Significantly, however, that testing will reveal only a limited view of the production real-world variability that will be discussed later as part of EMA's "margin stackup" analysis. It is important to note that EPA has not addressed this issue at all in its feasibility-demonstration efforts.

d. Even in the carefully controlled engine dyno-aging environment, the "Stage 3" solution is *non-compliant* with the proposed 0.020 g/bhp-hr NO_x standard

The actual results from SwRI's testing of the Stage 3 prototype are not compliant with the proposed Option 1 low-NO_x standards. This demonstrates that the Option 1 standards are not feasible. Focusing specifically on the results of the EPA Stage 3 RW system (which are slightly lower than the CARB Stage 3 engine results), set forth below are the lab-measured NO_x emission data points at 435,000, 600,000 and 800,000 mile-equivalent aging, as reported by SwRI:

Stage 3 RW Tailpipe NO_x Emissions (*and proposed standard*) (g/bhp-hr)

Certification test cycle	435k mile[7]	600k mile[7]	800k mile[7]
Composite FTP (transient)	0.022 (*0.020*)	0.029 (*0.040*)	0.040 (*0.040*)
Ramped Modal Cycle (steady-state)	0.019 (*0.020*)	0.026 (*0.040*)	0.031 (*0.040*)
Low Load Cycle	0.034 (*0.050*)	0.038 (*0.100*)	0.037 (*0.100*)

Recall that, for heavy heavy-duty engines, the interval from 435,000 miles to 800,000 miles will be held to a 0.040 g/bhp-hr FTP and RMC NO_x standard under EPA's Option 1 proposal. As the test results above show, EPA's Stage 3 prototype does not meet the 0.020 g/bhp-hr NO_x standard at 435,000 miles over the FTP certification cycle, and it generated results exactly equal to the "second stage" standard of 0.040 g/bhp-hr when tested to 800,000 miles. (The CARB Stage 3 engine generated a composite FTP result of 0.031 g/bhp-hr at just 290,000 miles equivalent aging before the engine was recalibrated mid-testing to reduce the tailpipe NO_x to 0.023 g/bhp-hr at the

[7] Figures are mileage equivalents, achieved by aftertreatment bench-aging methods. The engine, however, including cylinder deactivation and EGR cooler bypass systems, was not aged to determine deterioration effects.

expense of an almost 1% CO_2 emissions penalty. CARB terminated its testing at 435,000 miles-equivalent aging.) The emissions results reported by SwRI are, therefore, not fully compliant. Moreover, they are not even complete, since they only include the IRAFs that SwRI generated when the system was degreened, not when the system was aged. It is also clear that the SwRI results fail to account in any way for the necessary compliance margins.

Just as important, the Stage 3 RW CO_2 emissions, as measured by SwRI, are 2.3% above the HHD 2027 FTP CO_2 emissions standard for vocational engines, and 5.2% above the HHD 2027 RMC standard for tractor engines, an issue that EPA has attempted to downplay as immaterial to engine manufacturers' ability to comply with those future requirements, despite the well-established NO_x/CO_2 tradeoff that continues to challenge the diesel engine industry. More will be discussed on this significant point later.

EMA has funded additional testing of the Stage 3 RW engine over five "road cycles." Engine parameters were recorded during five actual on-road cycles, and then set up for engine-dyno testing. Those results were processed according to the new proposed "3-Bin Moving Average Windows" ("3B-MAW') in-use testing and compliance protocol. While only scratching the surface of the myriad cycles HD trucks will encounter in the field, the Stage 3 RW system (and the CARB Stage 3 system) failed one of the five initial road cycles (the EU ISC cycle, as developed by WVU according to EU In-Service Conformity requirements), since it yielded a NO_x result that exceeded the most stringent in-use "Bin 3" (medium/high power bin) limit of 0.030 g/bhp-hr by 10%. A second of the five road cycles was just at the Bin 3 limit, which SwRI improved later by preconditioning the aftertreatment system to ensure robust pre-test ammonia storage, a preconditioning process not permitted according to the applicable manufacturer in-use testing requirements.

Actual in-vehicle road-testing of a Stage 3 system obviously would be highly informative to the rulemaking process. Unfortunately, EPA (and CARB) conducted no such actual in-use testing of a vehicle equipped with the Stage 3 prototype engine, despite earlier commitments to do so. Rather, EPA's proposal of aggressive in-use standards utilizing a completely new 3B-MAW emissions measurement protocol is based solely on the partially failed emission results generated with one prototype engine operated on an engine dyno over just five simulated road cycles.

It also is important to consider that the Stage 3 technologies that serve as the basis for EPA's feasibility demonstration offer little or no improvement to NO_x emissions levels when operating over periods of sustained engine load, the types of operation that should be included in the medium/high-load bin ("Bin 3") of the proposed 3B-MAW protocol. For example, in the case of a line-haul vehicle pulling a load at highway speeds, a condition where SCR temperatures with current technologies would be at levels optimal for NO_x conversion, none of the proposed Stage 3 technologies (i.e., cylinder deactivation, EGR-cooler bypass, LO-SCR, heated dosing, zone-coated catalyzed soot filters, switchback mixing tubes) would have any impact on lowering tailpipe emissions levels, save perhaps for some marginal effect from increased SCR sizing. Yet EPA's Option 1 "Bin 3" proposal includes a 90%-lower steady-state NO_x standard associated with that type of already-optimized operation under quasi-steady-state engine operation. That is inherently infeasible.

e. There are important factors that EPA has not considered that will compromise manufacturers' ability to comply

The limited emissions test results generated with the Stage 3 RW prototype aftertreatment system, as aged in the laboratory environment, do not represent reasonable worst-case emissions performance, nor do they represent reasonable worst-case aging effects that can be expected from field-returned engines. There are in-use operating conditions and events experienced in the field that are not even considered in EPA's discussions of "technical feasibility," but for which diesel engine manufacturers are held accountable in assessing their compliance with EPA's emissions-related requirements.

There are two types of in-use real-world factors that need to be considered, since they can be detrimental to tailpipe NO_x emissions over and above the Stage 3 demonstrated performance. The first set of factors includes those that cause temporary increases, or increased variability of NO_x emissions, such as accumulated sulfur on aftertreatment systems (prior to a desulfation regeneration event), variable ambient conditions, and production variability. The second set of factors includes those that cause engine and aftertreatment systems to degrade to a greater degree than the "nominal" or "typical" degradation assessed through a test cell demonstration, whether that be a feasibility demonstration conducted on behalf of regulators, or a manufacturer's "deterioration factor" test run for certification purposes. Three examples are SCR poisoning due to fuel impurities, operation under more severe in-use duty-cycles, and inadequate maintenance practices. (A more comprehensive list of the various factors of concern will be provided later in these comments in the section related to EMA's efforts to quantify the additional NO_x reductions needed relative to Stage 3 NO_x emissions – i.e., the additional "margin" that is necessary to ensure robust emissions compliance in the field.)

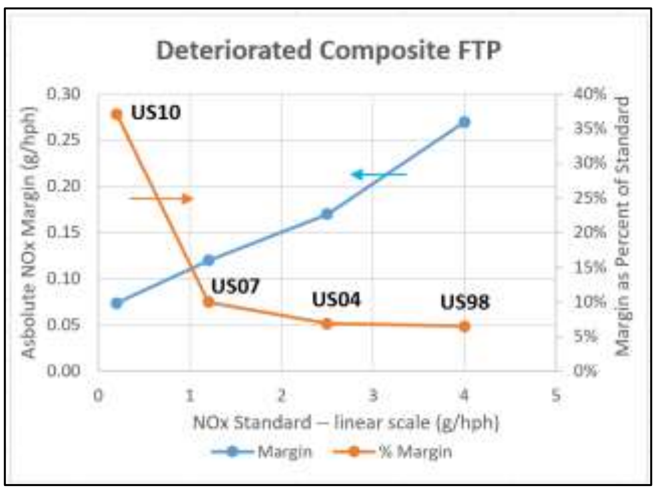
Those short-term and long-term emissions-impacting factors are risks that manufacturers will be held accountable for in designing their diesel engine products for robust emissions compliance, but which EPA has not considered in its "technical feasibility" demonstration. As explained below, the NO_x increases in response to those factors are far from trivial. Yet EPA has not presented any kind of technical analysis that even attempts to quantify the emissions increases that can result from those in-use real-world impacts. Thus, while it may be good enough for EPA that the Stage 3 engine "came close" to complying with a 0.020 g/bhp-hr verification standard (recall that actual compliance was not achieved over the FTP test cycle or over the EU ISC in-use road cycle), that is in fact not good enough to sustain a rulemaking of this significance.

Diesel engine manufacturers often use the term "margin" when talking about the headroom they must design into their emissions control strategies. Margin is the difference between the underlying emissions standard and the lower "as-designed" emissions performance that diesel engine manufacturers target for their products. Manufacturers must design and calibrate to provide for sufficient margin to ensure robust compliance after accounting for the myriad factors that can compromise real-world emissions performance, and thereby to protect themselves from recall actions, fines, and damaged reputations. The next section details how NO_x compliance margins have grown to become a larger and larger percentage of the emissions standards as those standards have been reduced, and what that could mean for the Agency's proposed low-NO_x standards.

f. There has been a steady increase in the required compliance margin relative to ever-tightening NO_x standards

EPA maintains a publicly available database containing information and test results that manufacturers submit with their annual applications for Certificates of Conformity, a prerequisite to offering engine products for sale in the U.S. Among the data included in those databases are the manufacturers' emissions test results recorded on the engines for which EPA approvals are sought. "Deteriorated" emissions test results (actual test results modified to include emissions deterioration factors) were compared to the underlying standard (or Family Emissions Limit ("FEL") in cases where the manufacturer chose to certify the engine family to a level different from the applicable standard as permitted under credit "averaging, banking and trading" programs). The compliance margin that manufacturers are building-in can be readily determined from this analysis. EMA scanned all relevant data from a single model year for each of the previous four NO_x emission-reduction steps to calculate the average compliance margin in each case.[8] The single model year was specifically selected to represent a "mature" view of the compliance margin to which manufacturers had "settled in" (that is, after compliant engines had been in production for a number of model years). The average FTP transient test margins are presented below in absolute and percent-of-standard terms:

Source	Model Year	No. of Families	Standard (g/bhp-hr)	Margin (g/bhp-hr)	% Margin
EPA database	2001	45	4.0	0.27	6.5%
EPA database	2006	52	2.5	0.17	6.9%
EPA database	2009	31	1.2	0.12	10.0%
EPA database	2021	26	0.20	0.074	37.1%



It is readily apparent that there has been a decreasing trend in the absolute (g/bhp-hr) margin (NO_x standard minus deteriorated certification result) as NO_x standards have decreased. That is, of course, necessary – the average margin of 0.27 g/bhp-hr for the US98 standard would be fundamentally unworkable with a US10 standard of 0.20 g/bhp-hr. More significantly, when examined as a percent of standard, the trend reveals a steadily increasing margin (orange line in graphic above) as NO_x standards decrease (from right to left), with the most significant increase associated with

[8] Certification test results from all heavy-duty diesel on-highway engine families included in the EPA database as manufactured by major manufacturers Cummins, DDC/Daimler, Volvo, Navistar, PACCAR, Hino and Isuzu were used (smaller manufacturer submissions were excluded). For consistency, and to maintain a view of margin's relationship to the relevant standard, engine families were excluded if they were certified to an FEL less than or greater than 15% of the applicable NO_x (or NO_x + NMHC) standard. For the NO_x "phase-in" period from 2007-2009 the relevant NO_x standard was assumed to be the "equally-split family" FEL of 1.2 g/bhp-hr.

the current US10 standard.[9] The reason for this trend is simple – the level of variability in production diesel engine emissions control, and long-term degradation, has not decreased linearly with the NO_x emissions standards themselves. Thus, the percentage of the standard reflected in those margins has gone up.

This should, in fact, be expected. Today's aftertreatment-based emissions control systems are far more complex than the systems deployed to comply with US98 and US04, and therefore more sensitive to ambient and other external influences, as well as sensor inaccuracies and the expected range of production variability. Furthermore, tailpipe NO_x emissions are very sensitive to SCR efficiency, and therefore the "high end" of long-term SCR degradation from fuel impurities, including metals in biofuel blends, or even severe service applications, can compromise NO_x control to a significant degree. Additionally, more fundamental factors that influence margin requirements, such as laboratory or field emissions measurement system accuracy, have not improved at levels proportional to the reductions of the underlying standards over the years. All of those factors, and more, have required diesel engine manufacturers to increase the requisite margin relative to the standard to ensure robust post-production compliance.

Further evidence that manufacturers depend on significant compliance margins comes from the fact that, despite the current on-average 37% margins, not a single HD diesel engine manufacturer had certified an engine family to a level below the current 0.20 g/bhp-hr standard until a single manufacturer did so with MY 2022. Certifying engine families to an FEL below the standard would allow a manufacturer to earn emissions credits, which would be extremely valuable as part of a product development plan to transition toward future low-NO_x standards. Yet even so, and after more than a decade of experience with the current US10 standards, and despite manufacturers' knowledge that a 75%-90% reduction in the NO_x standard is being targeted (making credits that much more valuable), not a single HD highway diesel engine manufacturer had taken the risk to certify products with an FEL less than the current 0.20 g/bhp-hr standard through model year 2021. As noted, one manufacturer has recently submitted model year 2022 applications for FEL-generating families in California, but even in that case, the manufacturer's deteriorated certification test results are much less than 50% of the FEL, yielding a margin greater than 50%. This pervasive reluctance to certify with an FEL below the current 0.20 g/bhp-hr NO_x standard, except in cases where unusually high margins can be provided for, highlights how essential significant compliance margins have become to ensure robust real-world emissions compliance.

EPA's failure to consider or provide for the necessary emissions-compliance margins is one of the key factors that establishes the fundamental infeasibility of Option 1. It also is a key factor in the assessment of how the Option 2 proposal will need to be modified. Indeed, without having conducted a careful examination of how the relevant real-world factors will contribute to the necessary margin requirements associated the proposed low-NO_x standards, it is clear that EPA's assertions of technical feasibility are deficient and, at best, premature.

In quantifying this issue, the percent of margin is clearly a more compelling metric than the absolute margin. If we return to the graph of progressively increasing emissions margins, the

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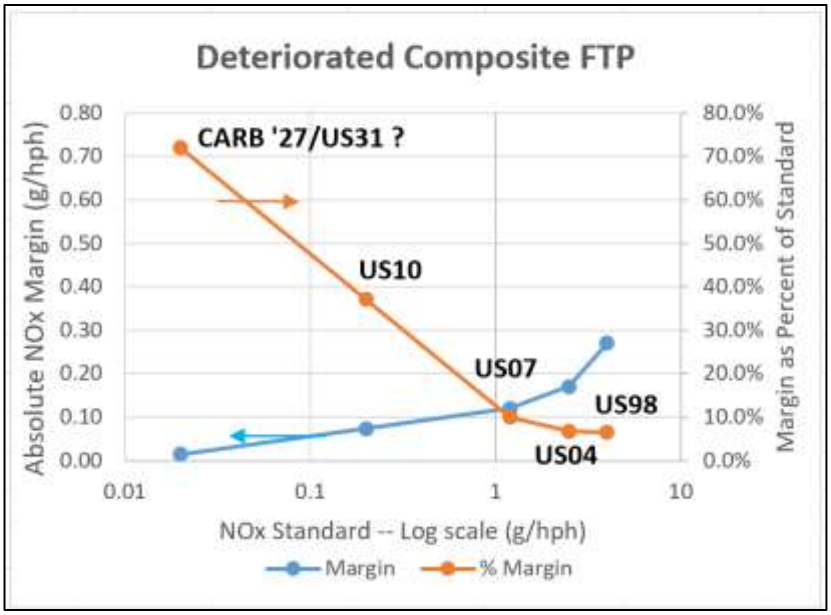
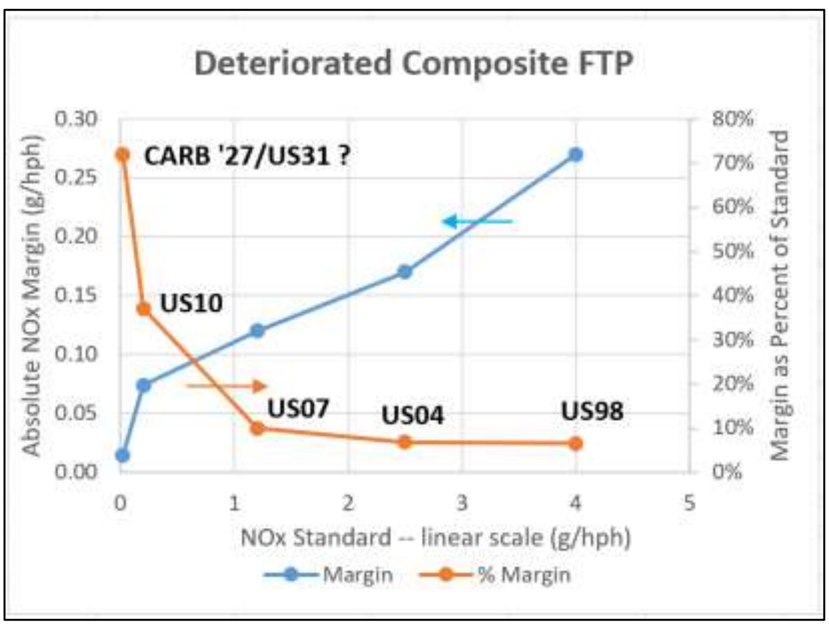
[9] A similar examination shows steady-state cycle (or Ramped Modal Cycle) average US10 certification margins to have increased to 70% of the NO_x standard.

shape of the orange curve indicates that it could be instructive to plot average manufacturer margin on a logarithmic scale. If we do so, and extrapolate the US04-to-US10 trend in a straight-line manner to a proposed 0.020 g/bhp-hr standard, the percent of margin required by this method would be just over 70%, which translates to an absolute margin of 0.014 g/bhp-hr, as depicted below:



Including these calculated margin requirements on the original linear-scaled graph yields the following graphic:



The dramatic bend in the absolute margin curve (in blue) is very concerning. EPA's inherent assumption that *less* margin is needed than the calculated 0.014 g/bhp-hr shown, would only sharpen the bend in the curve, and be even more concerning. The bottom line is that assuming the percentage trends in margin requirements continue to hold – and there is no reason to assume otherwise – in order to meet an Option 1 0.020 g/bhp-hr NO_x standard in a manner that could reasonably assure post-production compliance, diesel engine manufacturers would need to target an "as-designed" emissions performance level at or below 0.006 g/bhp-hr. There is no evidence – none – that such a zero-equivalent NO_x level is feasible. Indeed, if one considers the trends in absolute margins, manufacturers would need to target negative emissions from their engines, which is, of course, irrational and impossible. Again, the relevant data demonstrate that Option 1 is not feasible and should be abandoned.

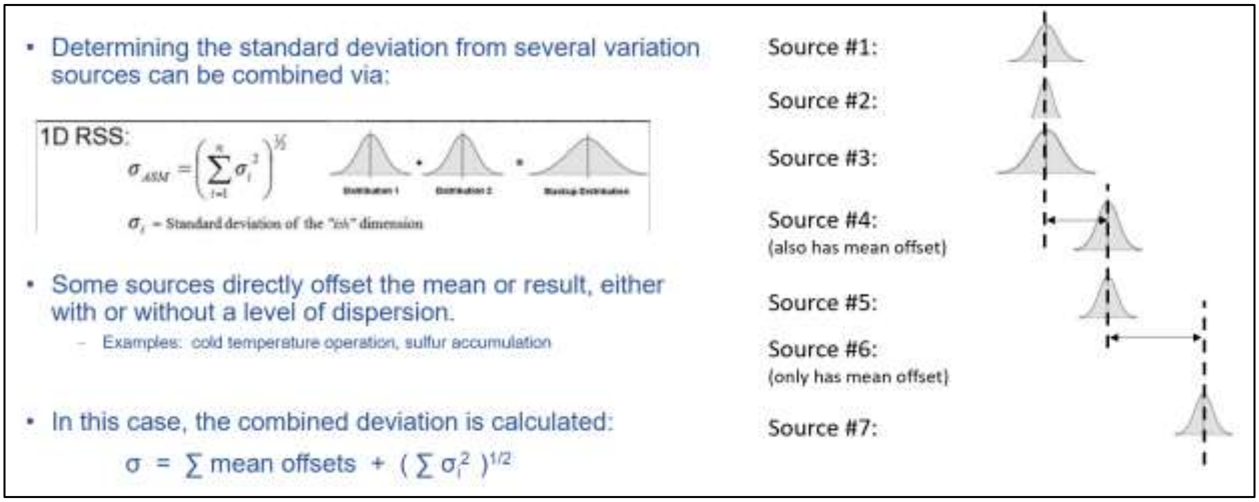
While EMA concedes that this extrapolation exercise does not provide a complete technical basis for understanding margin requirements in an era of ultra-low HDOH NO_x standards, it is nonetheless worthy of consideration. All diesel engine manufacturers will have to determine the level of margin required to comply with future emissions standards based on the capabilities of their emissions control systems. EPA should not gloss over or ignore the significance of this point. Compliance margin is a factor that the regulators – not just manufacturers – should account for in assessing feasibility. Accordingly, EPA simply should not finalize this rulemaking until this issue has been fully and fairly accounted for.

g. A statistical analysis of margin requirements is equally compelling

EMA has started to examine in more detail the influence of individual external variables on the stability of tailpipe NO_x emissions control. EMA's approach is to combine in a statistical manner the factors that can increase tailpipe NO_x variability, while also including those factors that drive a mean offset to tailpipe emissions, in an attempt to calculate how much additional improvement manufacturers will have to achieve *relative to the demonstrated performance of the Stage 3 RW solution.* The analysis seeks to take into account all those factors for which diesel engine manufacturers will be held accountable for emissions compliance, but that so far have not been considered as part of the Stage 3 RW (or CARB Stage 3) testing to demonstrate "technical feasibility."

Recall that the Stage 3 RW achieved a 0.022 g/bhp-hr tailpipe FTP NO_x emissions result at 435,000 miles. (Indeed, the CARB Stage 3 engine generated an FTP result of 0.031 g/bhp-hr at just 290,000 miles equivalent aging (purportedly to justify a 0.020 g/bhp-hr NO_x standard), before the engine was recalibrated mid-testing to reduce the tailpipe NO_x to 0.023 g/bhp-hr at the expense of an almost 1% CO_2 emissions penalty.) EMA has identified multiple factors, not yet considered by EPA, that would increase that demonstrated result by varying amounts. In light of those multiple factors, it is obvious that manufacturers would be left to improve upon the Stage 3 demonstrated result, first to eliminate the 0.002 g/bhp-hr exceedance as measured by SwRI, and second to overcome the multiple real-world emissions-aggravating factors.

The mathematical method applied in this "margin-stackup" analysis is straightforward and typical of multiple variability-source analyses:

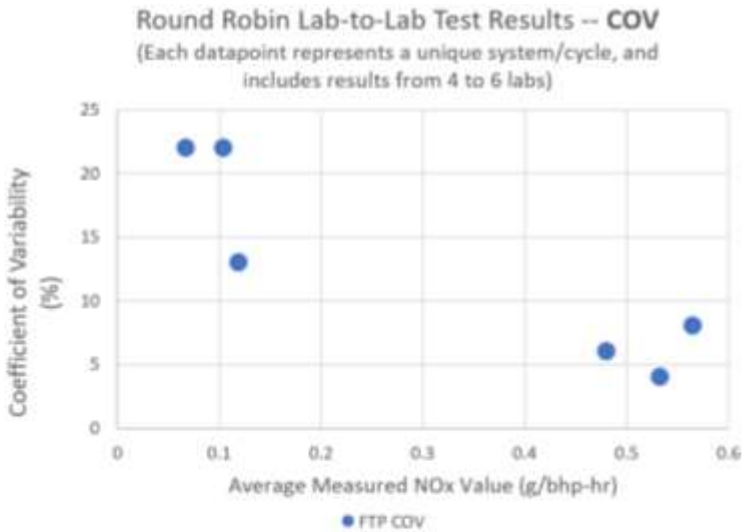


The various external sources of emissions-increasing variability and mean offset that EMA has identified have been captured in a spreadsheet set up to calculate the combined effects, as follows:

Applies to Dyno	Applies In-Use	Variation/offset driving margin requirement	Estimated Tailpipe NOx impact g/bhp-hr mean offset	std dev σ_i
		Custom calibration (e.g. SwRI demo project)	reference	
X	X	Nominal result in production	0.0020	
X	X	Production variability		0.0060
	X	Packaging limitations (long exhaust piping to LOSCR)	0.0020	
	X	Without aftertreatment preconditioning	0.0039	
X	X	Sulfur + soot accumulation (N_2O make)	0.0030	
X	X	Ash Accumulation	0.0010	
X	X	Maintenance practices		0
	X	Cold ambient operation	0.0023	
	X	Operation at altitude	0	
X	X	Severe-service duty-cycles	0	
	X	Fuel Quality, DEF quality (short term emissions effects)	0.0020	
X	X	Field deterioration (metals in bio-fuels, etc.)		0.0050
X	X	Lab measurement variability		0.0060
	X	PEMS measurement variability rel to Lab (CARB only)		0.0000
		TOTAL MARGIN REQUIREMENT, DYNO	σ =	0.016
			2σ =	0.026
		TOTAL MARGIN REQUIREMENT, IN-USE	σ =	0.026
			2σ =	0.036

Margin of σ: Protects that 84% of population are below demo reference
Margin of 2σ: Protects that 97.7% of population are below demo reference

The analysis above is a snapshot of work in progress. EMA is striving to identify the most relevant available sources of data to inform the data entries for each line item, and, to that end, we have pulled data from a variety of available sources. Several factors have been "scaled" linearly from reference levels to be reflective of the proposed new low-NO_x standards, which is unduly conservative for many of the reasons discussed earlier. For example, lab-to-lab NO_x measurement variability does not conveniently decrease by 90% just because the standard (and actual NO_x level) is reduced by 90%. A rigorous "round robin" measurement variability test program in which EPA participated demonstrates this point clearly. As depicted below, the coefficient of variability increased as the average measured NO_x value decreased:



To give another example of how available data were used to populate the margin stack-up table, consider the item identified in the table as "Fuel quality, DEF quality." For that element of the necessary variability allowance, EMA acquired information from an OEM reporting a 0.007 g/bhp-hr increase in NO_x from a US10-compliant engine fueled with B20 when tested over certification cycles, compared to operation with certification-spec fuel. When those results are scaled down conservatively to the proposed NO_x standard of 0.020 g/bhp-hr, the resultant fuel-impact increase is 0.0014 g/bhp-hr. A second relevant data source is a 2021 CARB study where the impact of a 35% biofuel blend was assessed on "new technology diesel engines" ("NTDE").[10] In that study, NO_x emissions increased over the FTP on a 2019 Cummins HDOH engine, and over the NRTC on a 2018 NTDE non-road Caterpillar engine. The (again, conservatively) scaled-down results from those tests would forecast a fuel-impact increase in NO_x emissions of 0.0090 to 0.0178 g/bhp-hr from operation on biofuel. Several stakeholders have expressed concerns regarding the validity of the CARB study. Accordingly, in the margin stack-up table above, EMA has relied mainly on the much lower reported NO_x increase from the OEM's fuel-impacts testing. In reality, however, we have no basis to assume the results would scale with the absolute tailpipe emissions, but EMA conservatively makes this preliminary estimate in the absence of other data.

Based on all of this information, and without yet evaluating the NO_x increases that may result from off-spec DEF, EMA included only a 0.0020 g/bhp-hr impact in the margin stack-up

[10] CARB Low Emission Diesel Study (LED): Low Emission Diesel (LED) Study: Biodiesel and Renewable Diesel Emissions in Legacy and New Technology Diesel Engines - Final Report (ca.gov)

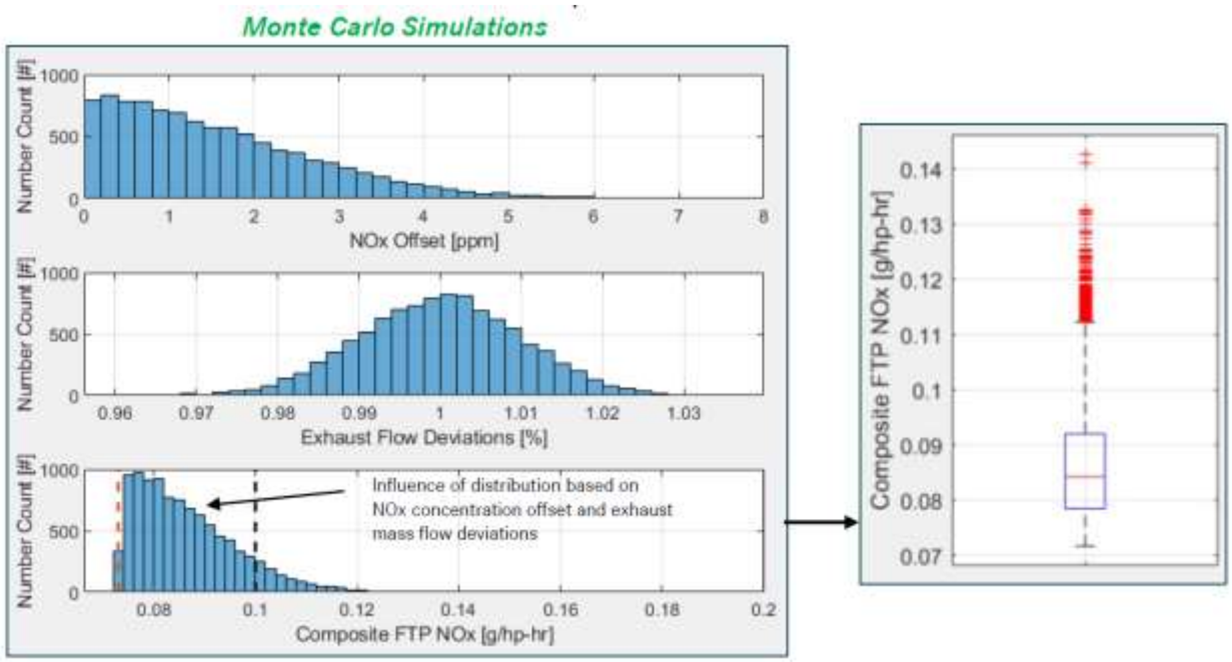
table. Importantly, the Coordinating Research Council will be evaluating the influences of several fuel formulations, including renewable fuels and biofuels, on tailpipe NO_x emissions. That study, to be performed by SwRI on the EPA Stage 3 engine, should be completed by mid-year, and will be directly relevant to the margin analysis at issue.

Some factors in the stack-up analysis are more relevant to measurements in a test cell, while others are more relevant to field measurements — or "in-commerce" increments — using portable emissions measurement systems, or "PEMS". For example, cold ambient operation will impact tailpipe NO_x emissions in the field, but will not be an issue impacting engine dyno tests in a lab. Several factors can play a role in both dyno-testing and in-use compliance testing. The spreadsheet is setup so that only those factors for which an "x" is entered in the appropriate columns to the left of the chart are included in the corresponding calculated results at the bottom of the chart.

One important aspect of this margin stack-up analysis relates to the first line item in the table, labeled "Custom calibration." This is considered the "starting point" or reference for the analysis, because the work attempts to determine how much better OEM products must be compared with the SwRI Stage 3 RW demonstration to ensure robust compliance in the field. In this case, it is important to recognize that the Stage 3 RW engine was calibrated for optimized emissions control on a single test article. If 1000 production engines were built from the same specifications and using the same controls and calibrations, we should expect the average emissions performance of those 1000 engines to be somewhat higher than the custom-calibrated engine. (Any one of those 1000 engines could then be "custom calibrated" to improve its emissions control, but such a process would not be practical for a production environment.) In the spreadsheet, this delta between the custom-calibrated result and the production average result (not to be confused with production variability), was estimated at 0.002 g/bhp-hr in the line item, "nominal result in production."

Another probable increase to tailpipe NO_x emissions that has not yet been included in EMA's margin analysis stems from the fact that the SwRI Stage 3 engine is set up for a 500 HP rating. That is a rating that would normally be among the higher power ratings within an engine family for an engine the size of the Stage 3 prototype. Lower horsepower ratings would, in general, produce less thermal energy over the certification (and road) cycles, which would trend toward reduced NO_x conversion efficiencies from the SCR. A 400 HP rating, for example, would not be atypical for a manufacturer to provide for a Stage 3-like engine, and would likely have higher brake-specific tailpipe NO_x emissions. Data showing this effect has been shared with EPA. That emissions-increasing variable is not included in EMA's margin stack-up. Nonetheless, the Agency will need to consider this point when setting the final standards, including sufficient variability allowances, relative to the emissions performance that the Stage 3 demonstration engine was able (and unable) to achieve.

To further illustrate the sensitivity of modern diesel engines and their emissions control systems to minor variability influences, one manufacturer conducted a Monte Carlo analysis to assess the influence of small perturbations in NO_x, or NO_x control variables on composite FTP results. The analysis involved simulating an array of small NO_x concentration perturbations according to the uppermost graph below, coupled with minor exhaust flow measurement error sources. The range of influence to composite FTP results is shown in the graph at right.

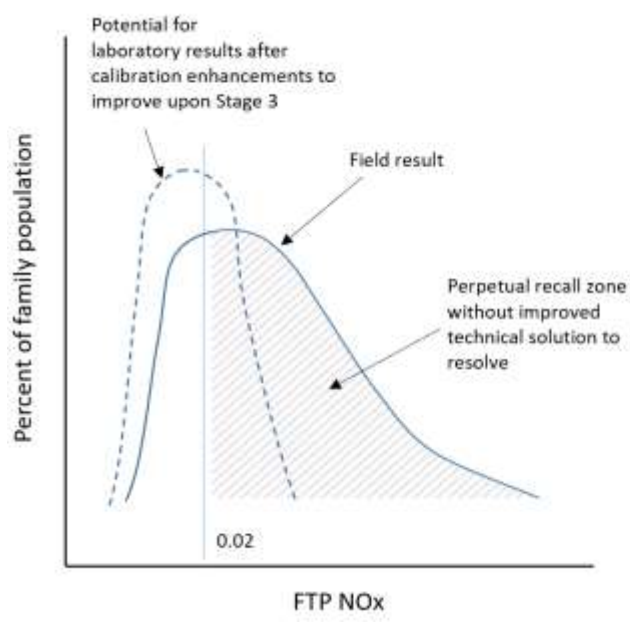


This additional Monte Carlo analysis emphasizes the extreme sensitivity of tailpipe NO_x emissions to small sources of variability, especially at low absolute tailpipe NO_x levels. This is the concern that lies at the heart of the margin stack-up analysis, and the fundamental feasibility issues that necessarily stem from it.

Returning to the margin stack-up analysis, some have questioned the validity of combining several of these factors to quantify the impact on the real emissions development targets that manufacturers must establish, claiming it is unrealistic to expect all of them to occur in combination. The simple fact, however, is that as long as EPA expects manufacturers to design their products to ensure full in-use emissions compliance for all production engines and vehicles without allowing any special procedures to precondition aftertreatment systems — including under conditions just before regenerations are triggered, up to the point of the prescribed DPF ash cleaning maintenance, without regard to marginal maintenance practices, in cold ambient conditions and at high altitudes, regardless of the vehicle's application, and while operating on a wide range of market fuels (EPA's proposal would require compliance with "any commercially available biodiesel fuel blend that meets the specifications for ASTM D975 or ASTM D7467") — then the combined effect of *all* of those emissions-impacting factors *must* be taken into account when establishing the tailpipe NO_x design targets that define the requisite compliance margin. In other words, EPA must account for all of those factors when assessing what are and are not achievable standards, just as manufacturers are compelled to do.

Again, this "margin stack-up" analysis remains a work in progress, but the initial results are nonetheless quite striking and concerning. This evaluation, using conservative values in many cases by applying a linear scaling assumption to the proposed low-NO_x standard levels, indicates that OEM products must perform 0.016 g/bhp-hr better than the Stage 3 RW engine if protecting for a 1σ compliance level (84% of production engines compliant), and 0.026 g/bhp-hr better if protecting for a 2σ compliance level (97.7% of production engine compliant). There is a clear irrationality from these results when assessed against a 0.020 g/bhp-hr standard. More specifically, the proposed standards are shown to be fundamentally infeasible, since **the requisite compliance margin is larger than the standards.** (Note that the analysis as shown does not account for the 0.002 g/bhp-hr by which the Stage 3 RW engine exceeded the proposed 0.020 g/bhp-hr proposed FTP transient standard, an exceedance that manufacturers will also have to make up for through improved designs.)

Without making allowance for the various factors that contribute to manufacturers' necessary compliance margin requirements, EPA would be setting OEMs up for certain failure. The graph below shows the difference, in terms of NO_x emissions distribution for a family population, between what manufacturers *may* be able to accomplish in a Stage 3 demonstration-like laboratory setting (after the still-needed improvements to Stage 3 performance), and how that same engine family could perform in the field. The non-compliant zone in shaded grey, in essence, amounts to a "perpetual recall zone." In that zone, manufacturers would face a continuing series of recall actions, for which there would be no available improved technical solution to resolve the recall. Likely, the only available response from manufacturers would be to recover some level of NO_x control by replacing the aftertreatment systems, which would mean that EPA would have failed to achieve one of the goals it set in this rulemaking. Alternatively, if the replacement of aftertreatment systems proved too costly or impractical, the remaining options for OEMs faced with Option 1-like standards would be perpetual recall, or exiting the market.



One way for EPA to account for the emission variabilities that inevitably result from real-world operations, as detailed in the margin stack-up above, is to provide for a "variability allowance" that would be applied when assessing in-use emissions compliance of engines in (or from) the field. The variability allowance would be established based on best-available data, akin to that summarized in EMA's margin stack-up, and would be applied as an additive compliance margin during in-use testing, or when in-commerce engines pulled from a vehicle are dyno-tested over the certification cycles. Such an approach would avoid unfair and unwarranted compliance issues for OEMs stemming from variabilities well outside their control, while preserving the integrity of the Option 2-like standards that could be justified based on EPA's limited, and partially unsuccessful, feasibility demonstration.

h. The capabilities of stoichiometric combustion SI engines do not justify the proposed standards for CI engines

At a fundamental level, it appears that EPA has simply failed to take into account the inherent technical challenges that lean-burn engines present as compared to spark-ignited, stoichiometric burn engines, as well as the degree to which all of the real-world in-use variabilities impact NO_x emissions from lean-burn engines.

Lean-burn engines are inherently more efficient than stoichiometric-burn engines, largely due to the "free-breathing" unthrottled air intake system, higher compression ratios, and the higher energy density of diesel fuel (15% higher than gasoline). This superior efficiency, and therefore more environmentally favorable CO_2 emissions profile, coupled with exceptional durability, is what makes lean-burn diesel engines the powertrain of choice for the heavy-duty truck market. Lean-burn engines, and their low-CO_2 emissions performance, however, do come with significant technical challenges when it comes to controlling emissions, especially with respect to aftertreatment controls. Those technical challenges, coupled with the sensitivity of aftertreatment to real-world factors, compel the manufacturers of these engines to certify their products with much higher compliance margins than their spark-ignited counterparts in order to ensure their continuing in-use emissions compliance.

In that regard, there are a number of inescapable physical and chemical differences between diesel and spark-ignition engines and their aftertreatment systems that result in the different requisite compliance margins at issue, including the following:

- Part of what makes a lean-burn diesel engine more efficient is also what makes its real-world in-use NO_x emissions much more variable. More specifically, a diesel engine's unthrottled, variable air-to-fuel ratio combustion process leads to highly variable exhaust compositions and temperatures, which create many unique challenges for the engine's SCR-based NO_x emissions aftertreatment system. In contrast, a stoichiometric natural gas (or gasoline or propane) spark-ignition engine's exhaust has a nearly constant composition and its temperature is stable under nearly all operating conditions after initial warm-up. Spark-ignition engine exhaust is simply less variable, so it takes less effort to control those emissions. Diesel exhaust also experiences more extreme fluctuations between high temperature and low temperature operations where the catalyst is more susceptible to degradation.

- Because of those inherent exhaust stream differences, a diesel engine requires a more complex diesel particulate filter and selective catalytic reduction aftertreatment system, which is comprised of at least four different temperature-sensitive catalysts. It also requires precise, real-time thermal management and dosing of ammonia-forming Diesel Exhaust Fluid ("DEF") into the exhaust. SCR requires sophisticated electronics and fast and accurate wide-range sensors to actively control the entire system. The particulate filter requires periodic high temperature regeneration to remove its accumulated soot, temporarily interrupting the SCR's NO_x reduction performance. In sum, a diesel engine's emissions control system is much more complex than a spark-ignition engine's three-way catalyst(s) and single "on-off" (switching) oxygen-sensor-based control system. Unlike diesel engines, spark-ignition engines inherently maintain exhaust temperatures suitable for high efficiency catalyst performance over all operating conditions shortly after engine start. Diesel engine controls, however, must modulate DEF injection according to many factors, including variable exhaust temperatures to which NO_x conversion efficiency is very sensitive. EPA acknowledges the complexity behind the DEF dosing-control function, which it described in the Agency's RIA, as follows:

> *Urea dosing control takes into account a number of different factors, including:*
>
> • *The stoichiometry of NO_x reduction by NH_3 (1:1 or 4/3:1 molar ratio)*
> • *Molar ratio of $NO:NO_2$ at the inlet of the SCR catalyst*
> • *The amount of NH_3 stored and released from the zeolites*
> ° *Thermal desorption of stored NH_3 can allow NO_x reduction to occur at exhaust temperatures that are often too low for urea injection and decomposition*
> • *The degree of urea/exhaust mixture preparation of the system design*
> ° *Droplet formation and evaporation*
> ° *Induced turbulent mixing of aqueous urea and exhaust to aid droplet breakup*
> • *The efficiency of urea decomposition to NH_3 (> 95-98% at >250°C is typical for*
> *modern injector/mixer designs)*
> • *The probability forming solid deposits at low exhaust temperatures from partially*
> *decomposed urea*
> ° *Urea injection at exhaust temperatures below approximately 180 to 200°C can result in significantly increased deposit formation depending on mixture preparation and other factors*
> ° *Urea injector fouling can occur from deposit build up on the urea injector tip and other exhaust system surfaces*
> ° *Deposits can temporarily deactivate active catalytic surfaces, requiring higher temperature operation in order to remove the deposits*

Small errors in dosing can lead to significant variability in tailpipe NO_x. Underdosing causes inadequate NO_x conversion, while overdosing causes ammonia slip which is converted to NO_x in the ammonia slip catalyst. Either case increases tailpipe NO_x.

- More generally, the number of emissions-related components used in diesel engines is significantly greater than for spark-ignited engines. That simple fact, coupled with the greater complexity of a diesel engine's aftertreatment system and related control algorithms, inevitably leads to greater emissions variability, especially under the broad range of real-world in-use operating conditions that heavy-duty diesel vehicles encounter.

- As mentioned, diesel aftertreatment systems operate across a wide range of exhaust temperatures with associated variable NO_x conversion efficiency, and lean-burn exhaust chemical compositions. Because of this, tailpipe emissions are sensitive to small reductions in catalytic activity caused by thermal and chemical aging effects. Spark-ignited applications with three-way catalysts, however, are more tolerant of thermal and chemical aging effects because the "starting point" (the degreened system) has more NO_x compliance headroom. Moreover, the diesel fuel supply is more likely to contain contaminants than the gasoline supply, such as the metals commonly found in biodiesel blends. Long-term degradation of aftertreatment in compression-ignition diesel applications is further exacerbated by significantly longer useful life requirements than most spark-ignited applications and stoichiometric exhaust composition conditions. Of note, those already-longer useful life requirements are proposed to be extended even further – almost doubled - under EPA's proposed Option 1.

Spark-ignited gasoline engines have a strong advantage over diesel engines when it comes to the ability to robustly and consistently reduce engine-out NO_x to near-zero tailpipe emissions, but that advantage does not extend to CO_2 emissions. Forcing diesel products out of the market through the adoption of infeasible low-NO_x emissions standards would force vehicle owners into higher CO_2-emitting spark-ignited solutions, a highly counter-productive outcome.

The high-efficiency lean-burn engine's necessarily complex emissions control system, and the several other factors raised in this section, increase the in-use emissions-variability of diesel engines in ways that EPA has not accounted for. All of these factors necessitate compliance margins that make a 0.020 g/bhp-hr NO_x standard inherently infeasible for HDOH diesel engines.

i. Manufacturers cannot "calibrate their way" to robust Full Useful Life compliance

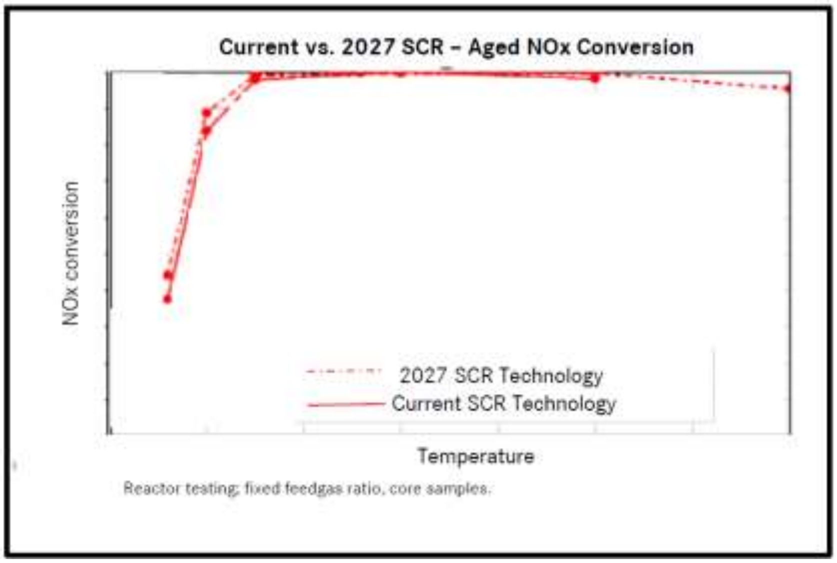
As noted, EPA has overlooked the gap between the proposed 0.020 g/bhp-hr HD NO_x standard and the actual results of the Stage 3 and Stage 3 RW "feasibility demonstration" by claiming that manufacturers will continue to work on control strategy optimization and final calibration to overcome the exceedance (and one must assume, the required compliance margin). That claim, however, is simply not reasonable when assessed against the reality of what is, and what is not, technically feasible.

At the macro-level, there are three technology paths to consider for reducing tailpipe NO_x emissions over and above that demonstrated by the Stage 3 solutions:

- **<u>Reduce engine-out emissions</u>:** In theory, a reduction in engine-out NO_x emissions could result in a reduction in tailpipe NO_x. That could be achieved with higher EGR rates, adjustments to injection timing, or other strategies. However, those techniques necessarily would increase CO_2 emissions, another regulated emission. The Stage 3 RW engine, as demonstrated, has 5.3% higher CO_2 emissions than the 2027 HHD tractor CO_2 emissions standard, and 2.3% higher than the vocational engine CO_2 standard. In fact, the final SwRI calibration does not even meet the 2021 GHG standards, and has CO_2 emissions slightly higher than the baseline Cummins X15 production configuration from which the Stage 3 RW system was developed. Overcoming an additional CO_2 deficit caused by reducing engine-out NO_x further to bring the Stage 3 RW system into compliance (with margin) will require *additional CO_2-reducing technology over and above what EPA has included in its feasibility demonstrations, rendering any related cost analysis inherently deficient.*

- **<u>Increasing exhaust temperature</u>:** Increasing exhaust temperatures at light loads to improve SCR NO_x conversion efficiency over a broader range of operating conditions would decrease tailpipe NO_x emissions. That could be achieved through actions to decrease engine combustion efficiency, more frequent dosing of diesel fuel across the DOC, or by adding a spark-ignited burner system or electrically-heated catalyst upstream of one or both of the SCR units. Any of those actions also would increase CO_2 emissions, thereby requiring additional CO_2-control technology to comply with CO_2 emissions standards that will be taking effect along with the future NO_x standards. Such methods to overcome the Stage 3 system deficiencies will likewise require *additional technology over and above what EPA has included in its feasibility demonstrations, again rendering any related cost analysis inherently deficient.*

- **<u>Improved SCR efficiency:</u>** If manufacturers were able to develop SCR NO_x conversion efficiencies superior to the capability of the systems included in the Stage 3 demonstrations, that could be an effective means to overcome the deficiency of the Stage 3 solution. That is not a viable solution, however. The SCR conversion efficiencies observed with the Stage 3 RW engine are already unrealistically high when compared to manufacturers' experience with high mileage systems in the field. The Stage 3 RW engine at the 435,000 mile intermediate UL equivalent aging had a 99.3% overall conversion efficiency on the composite FTP transient test, and still produced a *failing* 0.022 g/bhp-hr result. The RMC barely passed at 0.019 g/bhp-hr despite having a 99.6% cycle SCR conversion efficiency. If a field sample were to degrade a mere 0.3% more, that RMC result would escalate to a badly failing 0.026 g/bhp-hr! While SCR manufacturers have made strides to improve the long-term durability of SCR catalysts, for example with the introduction of FeZe/CuZe "hybrid" catalysts, manufacturers with three or more years' experience with those systems in production have found that they offer only marginal improvements, at best, compared to their predecessor configurations The following graph compares test results from aged systems, comparing this new generation hybrid SCR (labeled "2027 SCR", though the manufacturer has had it in production for 3 years) to the former technical solution (labeled "current"). The manufacturer is reporting that the aging characteristics of the new hybrid SCR configurations are not proving to be superior to the old configuration.



The conversion efficiencies achieved in the laboratory aging process, while producing barely compliant or even non-compliant results, are unrealistic to expect consistently in the field. This issue is even further exacerbated by the growing prevalence of biofuels in the marketplace, with known aftertreatment degrading characteristics. Significant increases in aftertreatment sizing could be considered, but not without backpressure increases driving higher CO_2 emissions, increased heat demand from the same exhaust flow, and a significant increase in cost. Once again, overcoming those CO_2-increasing measures would require *additional technology over and above what EPA has included in its feasibility demonstrations, rendering any related cost analysis for Option 1 inherently deficient.*

In summary, while one might expect that additional work on system optimization may be available to achieve **minor** NO_x reductions over and above the performance of the Stage 3 RW system, the levels of improvement required to comply with the Option 1 standards are simply not achievable without significant additional hardware and accompanying control strategies, including new CO_2-mitigation measures. Manufacturers are, in effect, "boxed in" by all of the constraints explained above. As with any development project to industrialize new emissions control concepts, there will be many other emissions-compromising technical challenges to overcome that have not yet even been imagined. Thus, the Agency's claim that manufacturers can simply calibrate the Stage 3 system into a robust compliance solution, given all that we know about aggravating factors and substantial margin requirements, is simply unreasonable.

Based on the foregoing analysis of margin requirements, and given the inherent technological constraints, the case could easily be made that it would be incumbent upon manufacturers to design for a compliance margin greater than 50%, and a margin as high as 75% could be necessary in the end. Under such assumptions, manufacturers would be forced to reduce Stage 3 RW FTP results by 55% to 75%, respectively. Reductions of that scale **cannot** be achieved with mere calibration efforts. The Agency's claim to the contrary has no sufficient basis in fact.

From all of the foregoing, it is clear that the Agency has failed to (and cannot) demonstrate the technical feasibility of a 0.020 g/bhp-hr FTP/RMC NO_x standard for HDOH diesel engines. The proposed technology set, some components of which present serious technical risks to product reliability and durability, has proven incapable of achieving compliant results in dyno-based certification tests and when tested using in-use road-cycles replicated on the engine dynamometer. More than that, the variety of short-term and long-term NO_x emissions-increasing factors that can impact field-sampled engines have been given no consideration in those attempted demonstrations. Recent trends of increasing compliance margins (when examined as percentage of prevailing standard) as represented in manufacturers' certification test results clearly demonstrate manufacturers' consistent need to over-comply in certification demonstrations, so that they can manage the additional and significant emissions-compromising influences under all real-world operating conditions.

Without a more robust demonstration that an improved technology package is capable of consistently complying with the proposed Option 1 standards, it is apparent that such standards, along with their related in-use emissions requirements, are **not technically feasible.** Accordingly, it would be manifestly unreasonable for the Agency to proceed with the adoption of Option 1. In fact, doing so likely would drive diesel engines from the HDOH market, which would significantly jeopardize the nation's economy and security. EPA is not authorized to do that.

j. EMA is supportive of idle-NO_x controls, but has concerns about the proposed standards

EMA supports EPA's proposal to include a voluntary "low NO_x idle" emissions standard, and to base that standard on the CARB idle-NO_x test procedure that has been in place since 2008. The specific proposed standards are a concern, however, because compliance to an idle-NO_x standard is contingent upon the low-NO_x technologies that will need to be deployed to meet the FTP, RMC and LLC standards, which will not be fully known until the rule is finalized. In addition, future developments related to the electrification of the HD fleet will offer new, more practical alternatives to reduce emissions from extended idling.

CARB created a two-speed idle emissions test procedure to support a voluntary idle-NO_x standard as an alternative to a 5-minute non-programmable automated shutdown requirement. EPA is now proposing a voluntary idle-NO_x standard of its own to reduce emissions during periods of extended idle, such as during loading and unloading operations, as well as during the extended idling to provide overnight hoteling loads. The Agency's proposed idle-NO_x standard would be based on the same CARB test procedure, at a level matching CARB's low-NO_x idle standard of 5g/hr, effective with MY 2027. The voluntary standard would initially become available in MY 2023 at 30g/hr, and then would be reduced to 10.0g/hr in 2024.

As an initial matter, there are no significant industry-wide planned engine or aftertreatment upgrades anticipated for model years 2024 through 2026. As manufacturers work to develop emissions control strategies to comply with the MY 2027 standards (while also evolving their product lines to zero-emissions solutions), there are minimal resources available to develop new technical solutions to achieve idle-NO_x emissions controls superior to those offered today, and too little time to develop and verify the new hardware solutions that would be needed. For this reason, EMA recommends that the optional Idle-NO_x standards *remain at 30.0 g/hr* for MY 2024-2026, and that EPA incorporate by reference CARB's test procedures and other clean-idle requirements for MYs 2024-2026, and that EPA incorporate by reference CARB's test procedures and other Clean Idle requirements for MY2024-2026.

EPA also proposes in §1036.104(b) that, "The mass emission rate of HC, CO, and PM in g/ hr during the Clean Idle test may not exceed the emission results from the idle modes of the SET duty cycle as described in §1036.505(h) or the idle segments of the FTP duty cycle as described in §1036.510(g)." That proposed requirement is unworkable. First, it is impractical to measure PM emissions over short durations of a cycle test. The PM demonstration requirement is also unnecessary, because today's HDOH PM standards require the use of DPFs to comply, which provides the maximum PM reduction technically achievable. The requirement to measure and demonstrate PM emissions levels relative to the optional idle-NO_x-measured PM emissions should be eliminated.

Regarding HC and CO emissions during the optional idle demonstration test, the proposed requirement that those emissions not exceed the levels measured in the idle portions of the FTP and RMC is essentially a requirement that the optional idle performance be designed to *decrease* the HC and CO emissions relative to the FTP and RMC, including to overcome test-to-test variability and minor fluctuations with operating conditions. EMA questions the need for HC and CO controls to be in place during extended idle conditions, as there would be no perceived benefit to manufacturers to calibrate that mode of idle operations to include higher concentrations of HC or CO. As a result, there is no basis for the proposed requirement. If the Agency nonetheless decides to constrain HC and CO emissions through regulation, EMA recommends setting time-specific standards under the clean-idle demonstration test for MY 2027 and beyond. Appropriate standards would have to be set following data review, especially from the Stage 3 engine or other engines similarly equipped. Another option, though not preferred, would be for EPA to require that the optional clean-idle results for HC and CO be no more than 30% higher than levels measured during idle portions of the FTP and RMC. EMA further recommends that §1036.104(b) state that EPA may approve alternative procedures with regard to controlling and demonstrating optional clean-idle NO_x, and potentially HC and CO levels.

With respect to the proposed NO_x standard starting with MY 2027, achieving an idle standard of 10.0 g/hr would require the use of CDA, elevated EGR rates, and/or additional load by way of an intake air throttle or similar technique. One or more of those strategies would be needed to increase aftertreatment temperature sufficiently to result in the enhanced SCR efficiencies required to achieve those levels. As discussed above, EMA has numerous concerns associated with the implementation of CDA on heavy heavy-duty applications.

NVH issues are the most significant concerns, with NVH being of particular relevance for hoteling needs during mandatory rest periods. The increased NVH with CDA could preclude maintaining the type of quiet, low-vibration environment that is critical to enabling proper driver rest during required service breaks. If alternating CDA control modes proves to be necessary to optimize the minimum SCR temperature/CO_2 emissions trade-off, or for long-term durability reasons, mode switching could be particularly disruptive to drivers' needs for restful sleep. Given that, there is additional concern that drivers will attempt to defeat or work around the CDA functionality or diagnostic capabilities to avoid those disruptions.

Other methods to reduce idle emissions, such as increased EGR rates are known to increase the frequency and severity of EGR cooler fouling, increased soot formation, catalyst face plugging, and aftertreatment degradation. An alternative approach to increase exhaust temperatures would be to increase engine loads through a variety of methods. While effective, that approach adds complexity, diagnostic burden, and an increase in CO_2 emissions and operating costs.

That said, starting in 2027, a 10.0 g/hr idle-NO_x certification standard could be achievable, with an additional 5.0 g/h NO_x variability allowance for any in-use testing. Anything lower than 10.0 g/hr would prove challenging to meet consistently across manufacturers' full product lines. For example, applications such as transit buses with high accessory loads may not be capable of meeting a standard less than 10.0 g/hr. Additionally, idle standards lower than 10.0 g/hr could disrupt product plans that involve the use of ABT provisions to bring the entire engine lineup into compliance with the new standards. Accordingly, EMA recommends that EPA finalize the rule with a 10.0 g/hr optional idle-NO_x standard, and also provide a 5.0 g/hr NO_x variability allowance for any in-use testing.

EPA has requested comment regarding whether an approved hood label should be provided for to inform local enforcement personnel that the vehicle is equipped with an engine compliant to the optional low-idle emissions standard. EMA believes it is ***imperative*** that such a label be specified and controlled in a manner similar to CARB's approach to its CLEAN IDLE hood label. Without such a federal label, there is no easy way for enforcement personnel to know that the vehicle's idle emissions are well controlled.

EPA also should secure agreement from CARB that the State of California will allow vehicles with the federal clean-idle label to idle for extended periods in California, including overnight idling, in the same way that the State acknowledges the CARB CLEAN IDLE hood label. This should be the case even if the federal idle standard is not as stringent as California's. The federal voluntary clean-idle standard, and its associated label, will be an important feature for various municipalities and states outside of California to allow for extended idle operation in locations currently requiring the CARB CLEAN IDLE label. Without those necessary label provisions, including authorization to idle for extended periods in California and elsewhere, there will be no incentive for manufacturers to develop clean-idle capability, or to certify their products to the optional clean-idle standard.

Regarding idle requirements for SI engines, §1036.115(j)(1) requires that manufacturers maintain 350°C catalyst bed temperatures during extended idle. EMA supports the option to propose alternative strategies to prevent emissions from increasing during extended idling.

k. The Stage 3 results demonstrate that the reduction in the PM standard is not technically feasible

SwRI presented the initial 800,000 mile aging results for PM from the Stage 3 prototype engine at the April 2022 SAE World Congress Exposition. Those results showed multiple RMC and LLC test results exceeding the proposed 0.005 g/bhp-hr PM standard when tested after ash cleaning of the DPF. SwRI reported that it took 10 to 15 hours of operation before the emissions was reduced from PM levels as high as 0.007 g/bhp-hr, 40% above the proposed standard. EPA has provided no exception for PM standard compliance for any period after ash cleaning. EPA therefore requires compliance over all certification test cycles under any conditions (with proper pre-conditioning). Here again, the demonstration that EPA is relying on actually demonstrates that the proposed emissions standard is not technologically feasible. The current PM standard of 0.01g/bhp-hr should therefore be retained in the final rule.

l. The proposed extended useful life requirements undermine the technical feasibility of the proposed regulations

EPA proposes to significantly extend the emissions useful life periods for all primary intended service classes starting in MY 2027. For example, EPA proposes to almost double the UL requirement for HHDE (435,000 miles today, increased to 800,000 miles by 2031) and to require a 2.5x increase for LHDE (110,000 miles today, increased to 270,000 miles by 2031).

EMA does not support EPA's proposal to extend the useful life periods. The proposed changes will force manufacturers to adopt new emissions-related maintenance recommendations to replace aftertreatment systems rather than accept the significant risk of a non-compliance determination and the expense of one or multiple recalls late in the useful life. Because EPA will require manufacturers to pay for the aftertreatment replacement, manufacturers will necessarily recoup those significant costs at the only available opportunity, the point of purchase. Extending the useful life as proposed also will compel manufacturers to enhance the design of many emissions-related components, imposing even more costs on the buyer. The result would be a substantial increase to the initial purchase price of heavy-duty vehicles. (See Section 16 for more details about the cost implications of EPA's proposal.) The expected cost increases invariably will lead to deferred purchases, delaying the adoption of the latest, cleanest vehicles. EMA stands ready to work with EPA to finalize more appropriate useful life requirements in the final rule.

EPA proposes to continue the practice of including hours in the regulated useful life period for the heavy heavy-duty engine (HDE) class to account for engines "that operated frequently, but accumulated relatively few miles due to lower vehicle speeds" (87 FR 17501), based on a 20 mile per hour speed threshold consistent with today's heavy HDE useful life criteria of 435,000 miles and 22,000 hrs. EPA has requested comment on the need for a useful life hours criterion for all heavy HDE, and whether they should include hours criterion for the other primary intended service classes. EMA supports continuing to include useful life hours for Heavy HDE as well as adding useful life hours for the other primary service classes of Medium HDE, Light HDE, and SI HDE. Just as in Heavy HDE, and perhaps even more so, there are applications within the other classes that accumulate relatively few miles due to lower vehicle speeds. It is also appropriate to use an average speed of 20 miles per hour in determining useful life hours for those other classes.

5. In-Use Testing for PM and NMHC Should Be Eliminated

In the Preamble to the NPRM, EPA requests comment on whether in-use testing for PM is still necessary. It is not, and should be eliminated. In fact, since the beginning of 2015 – more than seven years ago – EMA has been requesting that the Agency eliminate in-use testing for PM. EPA staff agreed with EMA on this matter in mid-2020, but have not taken the necessary steps to revise the relevant regulations. Now is the time to do that.

The background for this issue is important. The heavy-duty in-use testing (HDIUT) program, including for PM, resulted from the 2003 settlement of extensive NTE-related litigation (asserting that there were no sufficient test procedures for the then-new NTE standards). As part of that settlement, the parties (EMA, EPA, and CARB) negotiated a comprehensive outline of the NPRM for the HDIUT program, which included the following express provisions:

> The goal of this [HDIUT] program is to generate data on in-use emissions of heavy-duty on-highway diesel engines that can be used by EPA, CARB, and diesel engine manufacturers to ensure that emission standards are met throughout the useful life of 2007 and later model year heavy-duty on-highway diesel engines under conditions normally experienced in-use. The program is intended to monitor for NTE compliance and to help ensure overall compliance with emission standards.
>
> * * *
>
> In-use NTE emissions testing will include total hydrocarbons (THC), carbon monoxide (CO), oxides of nitrogen (NO_x), particulate matter (PM), and carbon dioxide (CO_2) (and also O_2)….Recognizing that experience may show that the effectiveness, durability and overall performance of new engine technologies and aftertreatment systems may demonstrate that in-use testing for certain pollutants may not be necessary, EPA/CARB will consider requests from the engine manufacturers to discontinue reporting and/or measurement of one or all engines based on test experience.

The follow-on final HDIUT rule was fully consistent with the parties' negotiated outline, and stated in relevant part as follows:

> All manufacturers will be regularly providing EPA with a significant quantity of data generated from engines used in regular service, which EPA will evaluate to ensure the engines comply with specified emissions requirements. The rule is a result of an agreement between EPA and the Engine Manufacturers Association. (70 FR at 34594.)
>
> * * *
>
> [HDIUT] is specifically intended to monitor compliance with the NTE exhaust emission standards and to help ensure that heavy-duty diesel engines will comply with all applicable emission standards (including those based on the FTP) throughout their useful lives. (70 FR at 34595.)
>
> * * *
>
> Recognizing that experience may show that the effectiveness, durability and overall performance of new engine technologies and exhaust aftertreatment systems may demonstrate that in-use testing for certain pollutants is unnecessary, we will consider requests from the engine manufacturers to discontinue reporting and/or measurement of one or more pollutants from some or all engines based on future test experience. (70 FR at 34610.)

Test experience, which EMA catalogued and shared with the Agency starting in 2015, has conclusively demonstrated that the measurement and reporting of in-use PM emissions is both unnecessary and costly. Thus, EPA should honor its commitment to eliminate HDIUT for PM. More specifically, since 2006, the relevant test results from the HDIUT program have demonstrated that there have been no "failures" for PM emissions. While one failure was initially reported, that vehicle was subsequently found to have a cracked DPF due to misfuelling. Indeed, EPA has acknowledged that there have been no in-use testing failures for PM under the HDIUT program. At the same time, in-use testing for PM is expensive, and requires a separate PEMS, elaborate installation configurations and vehicle mountings, significant additional vehicle recruiting and set-up time, and significant additional de-installation and post-processing time.

The proposed reduction of the certification standard for PM (from 0.010 g/bhp-hr to 0.005 g/bhp-hr) does not alter the justifications for eliminating PM from the manufacturer-run HDIUT program. As EPA concedes, that reduced standard will not drive any new DPF technologies; it is simply intended to prevent hypothetical "backsliding." Accordingly, no new risks of non-compliance are at issue. Moreover, eliminating manufacturers' in-use testing for PM will also eliminate the Agency's legitimate concerns of whether PM PEMS are up to the challenge of assessing in-use PM levels below 6 or 7 mg/bhp-hr. (See NPRM, 87 FR at 17468.)

There is an additional technical reason supporting the elimination of in-use testing for PM. In-use PM compliance is already monitored by on-board PM sensors. The failure mode for a DPF is cracking, which is easily detected by a PM sensor. Thus, if the goal of the HDIUT program for PM is to monitor DPF performance in-use, that is already robustly built-in with today's engines. Consequently, and as EPA staff has previously agreed, it is time to eliminate HDIUT testing for PM. There is no reasonable basis to do otherwise at this point.

It also is time to eliminate in-use testing for NMHC. The reasons for this are many and well-documented. First, there is a growing need to streamline HDIUT testing because the test burdens (the number of engine families and potentially the number of tests per family) continue to grow. Second, the HDIUT program is very disruptive to an OEM's customers, which makes it extremely difficult to recruit willing fleet-owner participants A smaller footprint in terms of installation time, vehicle space, and electrical power is required to streamline HDIUT testing to maintain a sustainable base of willing customers needed to support this program.

This is not a trivial concern. Installation of PEMS often involves the removal of certain items that can include passenger seats, windowpanes, storage boxes, bedding and personal belongings, and other accessories and equipment belonging to the customer or driver. There is always risk of damage to a customer vehicle, and customers are often surprised by the intrusive nature of a PEMS installation and left questioning what they agreed to. When a PEMS test needs to be repeated, the altered configuration of the vehicle sometimes limits flexibility in terms of the next assigned task for the customer vehicle. It is not unusual for a customer to need to alter their activities and/or driver schedules to accommodate an OEM's need for extended in-use testing. The ancillary in-use testing of NMHC and PM adds significant risks that additional days of testing will be necessary due to an issue with an analyzer. In sum, in-use testing needs to be less invasive to be sustainable.

Third, a streamlined PEMS (i.e., gas PEMS, without FID or PM PEMS) is much lighter and has a much lower power requirement, such that it is feasible to power it with Li-ion batteries or 12 volt power from the chassis electrical system, or both, potentially eliminating the need for a gasoline-powered generator and its associated hazards, space requirements, and possible delays during inspection at a truck scale, which can adversely affect customers' operation. A streamlined PEMS's would reduce staffing pressure for executing PEMS tests, could be installed in a reasonable amount of time with minimal disruption to the customer vehicle, and would eliminate the risks of voiding a test or rescheduling a test trip due to a PM or FID analyzer issue.

Other more technical issues also warrant the elimination of in-use NMHC testing going forward:

- Diesel engines are inherently low emitters of NMHC, and there have been few, if any, failures of in-use tests for NMHC emissions since the inception of the HDIUT program.

- Hazards and associated HazMat handling protocols for the use of FID fuel (DOT special permit and HazMat shipper certification) is an unnecessary risk. Customers often express concern over the FID fuel, and recognize that it adds risk for major disruptions during an inspection at a weigh station. NMHC testing puts OEMs in the position of directly asking a customer to assume that risk.

- The supply of FID fuel is expensive and unreliable due to the continuing Helium shortage.

- The 181°C heated line and FID temperatures that are necessary to avoid HC hang-up to keep HC's in gaseous form drive high demand for power that is limited in a PEMS application. Long heated lines are often necessary due to constraints on the location of the PEMS, which draw even more power due to their length.

- OEM's are already incentivized to reduce NMHC to manage risks of thermal runaway of an aftertreatment system contaminated with HC.

- Actions necessary to control engine-out PM also reduce HC emissions (i.e., high injection pressure, droplet size, and distribution). Low engine-out PM is desired to minimize EGR cooler fouling and to reduce regen frequency to improve IRAF and fuel economy driving a co-benefit of HC reduction.

- The base architecture of diesel aftertreatment systems includes an NMHC-reducing DOC necessary to support combustion of the injected HC that, in turn, is needed to support DPF regen cycles.

- The base architecture of diesel aftertreatment systems includes an AMOX catalyst necessary to control ammonia slip, which can also reduce NMHC.

- NMHCs from diesel engines are composed of heavy long-chain HCs lacking the volatility needed to contribute to ozone formation.

- HC standards are to be lowered under the NPRM, but that is driven by goals for SI engines (EPA stated goal is to maintain the same numerical standard for CI and SI). There is no intent to force any new technology to control HCs from CI engines, and CI engine currently easily comply with the NMHC standard.

In sum, there is no need for further incentives to control NMHC emissions; there is no undeployed control technologies for NMHC; and no environmental need that justifies the continued burdensome measurement of NMHC with PEMS in the HDIUT program. Accordingly, just as for PM, EPA should eliminate the need to conduct in-use testing for NMHC.

6. The Proposed "3B-MAW" Method for Assessing In-Use Emissions Needs to be Revised

One major new element included in EPA's proposal is a new method for "binning" and assessing in-use NO_x emissions, using a second-by-second moving-average window approach, with 300-second windows for collecting in-use NO_x emissions, and a 3-bin approach for sorting and evaluating in-use emissions based on average normalized CO_2 rates (the "3B-MAW" protocol).

The new in-use 3B-MAW protocol and its related standards are integral components of the efficacy of the proposed low-NO_x regulations. Consequently, that in-use methodology needs to be thoroughly evaluated to demonstrate its suitability and feasibility as a robust and effective in-use emissions-performance metric. The need to ensure a fully feasible 3B-MAW in-use compliance program is compounded by EPA's proposal to convert that program into one that leads, in effect, to strict liability and automatic recalls. Heretofore, there have been two phases of in-use testing. If an engine family does not meet the passing requirements of "Phase 1," then, following discussions with the OEM, "Phase 2" testing of 10 additional vehicles could be required to assess potential problems with emission controls. Even after that Phase 2 testing, however, engine recalls would not be automatic. By contrast, under the pending 3B-MAW proposal, all Phase 2 testing would be eliminated, and the need for engine recalls would be premised on strict compliance (or not) with the Phase 1 "pass" metrics.

That is a fundamental change in the rigor and consequences of in-use testing. Those consequences are further compounded by the fact that the in-use program, as proposed, will not merely assess real-world compliance with the underlying certification standards. Rather, and as noted above, EPA's new proposed in-use emission requirements would be, in effect, more stringent than the new certification standards, and would require additional aftertreatment hardware and additional engine development. (See 87 FR at p. 17475.) In sum, EPA is changing the paradigm of the HDIUT program, and is doing so in the context of Option 1 standards that are not achievable. The resultant recall risks and costs to OEMs will not allow for an implementable program if the Option 1 standards are finalized.

In that regard, it should be noted (again) that the Stage 3 prototype has not demonstrated robust compliance with the Option 1 3B-MAW standards. To the contrary, out of the five in-use drive cycles that SwRI used to test Stage 3 prototypes on an engine dynamometer, the Stage 3 system failed or just met the requisite standards over two of those cycles. If production families were to pass only at a rate of 3 to 4 out of every 5 vehicles tested, the vast majority of families would be determined to be noncompliant to the in-use requirements, and thereby potentially liable for recall. Thus, the feasibility of the Option 1 3B-MAW standards, like the Option 1 certification standards, has not been and cannot be established.

EMA has additional over-arching concerns related to the 3B-MAW protocol, including as follows: (i) the proposed NO_x-binning approach will result in individual seconds of data appearing multiple times in each of the 3 bins; (ii) the proposed methodology will result in a sorting, in effect a "smearing," of the same emission data points across all of the proposed bins; (iii) the 3-bin approach will disproportionally weight certain emission results over others (i.e., some data points will be included up to 300 times, while other points will not); (iv) the proposal for "concatenating" data across key-off/key-on cycles will result in an unrepresentative binning of dissimilar data, which will yield wide spreads in the binned results; (v) there is no discernable correlation among the data points that end up being binned together – the data variability and spread do not yield any consistent trends or significant differences among the 3 bins of data; (vi) the proposed binning method can result in randomly-binned data; and (vii) despite EMA's best efforts to find a workable NO_x-binning protocol, it is clear that using normalized CO_2-rate parameters alone is not sufficient to yield a protocol for binning reasonably correlated in-use NO_x data in three separate bins with three separate standards.

a. EMA has undertaken extensive more research to try to develop a workable in-use compliance standard

EMA was an initial proponent of moving to a new in-use-based emissions assessment paradigm, where each vehicle would become, in effect, its own mobile emissions lab. Such a new in-use paradigm, ultimately coupled with telematics, could allow for significant regulatory streamlining and greater assurance of real-world emissions control. EMA remains highly motivated to find a new in-use emissions-assessment protocol that can provide the framework for this new in-use regulatory paradigm.

In the interim, EMA and its members have devoted significant amounts of time and expense to exploring the strengths and weaknesses of MAW-based emissions binning tools and other potential in-use protocols. To that end, as noted above, EMA contracted with WVU to equip 100 HDOH vehicles with measurement technology capable of tracking emissions in real-world heavy-duty applications over extended periods. EMA has used that vast accumulation of fleet emissions data to evaluate numerous iterations of "binning" and other in-use emissions assessment approaches. Those iterations have included windowing techniques of various durations, exponentially-weighted moving windows, non-overlapping windows (or "tip-to-tail" windows), 1Hz-based approaches without windowed averages, and methods to better differentiate windowed emissions data on the basis of the engine's short-term operational history. EMA's research has included compliance evaluations not only on the basis of binning techniques, but also on the basis of the vehicle's shift-day "sum-over-sum" emissions. EMA's work also has included evaluation of adaptations to the Euro VI-based in-use testing protocol. Idle-bin boundaries based on vehicle and engine speed were studied, as were higher power level boundaries based on afterteatement thermal state to promote thermal management strategies, as well as brake-specific, CO_2-specific, time-specific, and distance-specific metrics.

Unfortunately, notwithstanding EMA's and WVU's extensive efforts (which are detailed in WVU's Report, see **Exhibit "A"**), EMA has not been able to identify a suitably robust bin-based in-use emissions-data assessment protocol. While EMA is continuing its investigations, one thing has become abundantly clear: EPA's proposed 3B-MAW protocol – which the Agency has copied from CARB – is not a well-reasoned regulatory framework for assessing in-use emissions compliance.

Consistent with the spirit and purpose of those comments, EMA has specific recommendations for how to revise the B-MAW approach so that it can serve as the basis for a new more-comprehensive in-use testing program. EPA requested comments on whether the 3B-MAW process should be modified, and more specifically whether combining bins might be a valid improvement over the protocol as proposed. As detailed later in these comments, EMA is recommending a modified two-bin approach.

b. WVU's expert analysis highlights the concerns with the 3B-MAW approach

The proposed 3B-MAW in-use testing method and standards do not sufficiently distinguish between modes of in-use engine operation, and so cannot adequately separate in-use emissions into separate bins of idle, low-load, and medium-to-high load operations. As demonstrated by the extensive analyses performed by WVU, the proposed 3B-MAW method can spread (or "smear") and comingle in-use emissions data across and among all of the three proposed bins. As WVU's work reveals, the binned data under the 3B-MAW method have no adequate correlation, trend lines, consistency, repeatability or reliability of results to support the establishment of separate regulatory standards for the three proposed bins. Moreover, EPA has not supported the proposed NO_x-binning method *with any actual in-use testing data* derived from compliant test articles or a low-NO_x HDOH prototype vehicle in-use. It is significant that the Agency originally committed to undertake real-world in-use testing of the proposed 3B-MAW protocol utilizing a Stage 3 prototype engine installed in a vehicle, but then reneged on that commitment, claiming that the Agency has run out of time.

WVU has prepared a comprehensive report of its findings and conclusions regarding the 3B-MAW in-use protocol. As noted, a copy of the WVU Report is appended hereto as **Exhibit "A."** The WVU report is based on emissions data acquired from WVU's testing of 100 vehicles of multiple vocations operating primarily in Southern California. The chart below shows the wide range of vehicle categories that WVU tested, and the number of tested vehicles in each category.

Category	Vocation	EMFAC Class	Vehicle Count
1a	Long haul	T7 NNOOS, NOOS, CAIRP	26
1b	Short haul	T7 tractor	23
2a	Port Drayage	T7 POLA	17
3a	Tractor construction heavy	T7 single construction	5
3b	Cement mixer	T7 single construction	6
4	Tractor construction	T7 tractor construction	8
6a	Food/Beverage Distribution	T6 instate small	8
6b	Moving / Towing	T6 instate heavy	15
7a	Goods distribution	T7 Single	1
7b	Moving	T7 Single	1

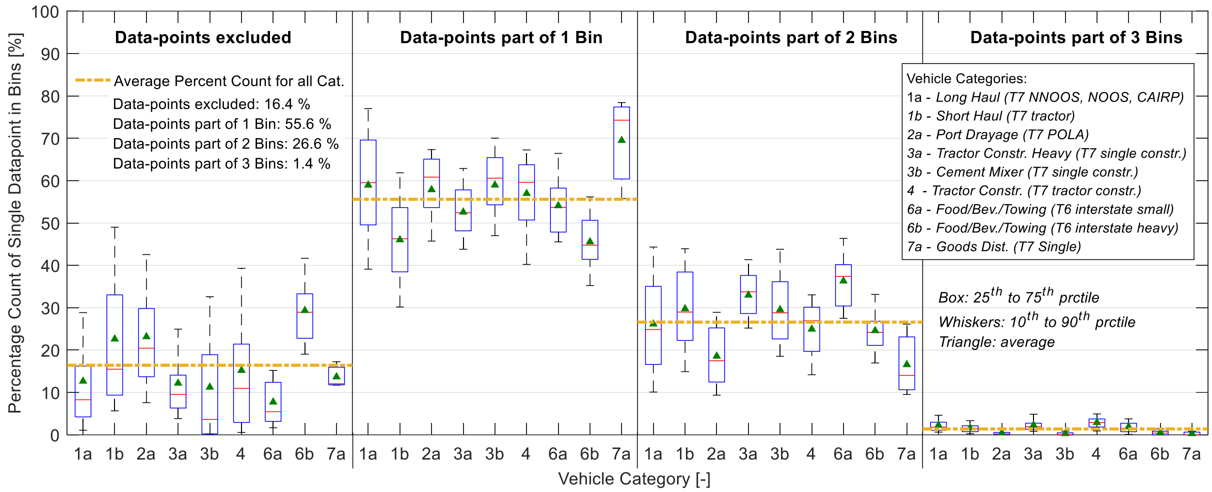
Each tested vehicle was equipped with NO_x-measurement instrumentation for a period of approximately one month, accumulating 20 to 30 test-days per vehicle. The second-by-second emissions and supporting engine and vehicle data were recorded and stored, and subsequently post-processed by the WVU Center for Advanced Fuels, Engines and Emissions ("CAFEE"). Of particular relevance, WVU has post-processed the large in-use emission data set using the proposed 3B-MAW protocol, and several variations thereof. WVU's results highlight the multiple problems inherent with the proposed 3B-MAW in-use protocol.

As an initial matter, the three proposed MAW-based "bins" do not actually represent idle, low-load, and medium-to-high load operations. Instead, they amount to a varying amalgam of all three bins when the binning methodology is applied. Moreover, in the end, the 3B-MAW protocol, with three separate in-use standards for each "separate" bin, in effect amounts to three potentially random chances to fail the 3B-MAW-based program.

By moving the proposed 300-second windows forward on a second-by-second basis, each measured one-second data point is included in up to 300 windows. Those windows are then sorted into one of the three bins. That means that single one-second data points end up being sorted typically 300 times into some varying combination of the three bins. For example, when second-by-second emissions data were recorded on a vehicle tested over CARB's "Southern Route," 25% of the datapoints fell into two bins, and 7% fell into all three B-MAW bins, rendering the "data segregation" among the three bins a metaphorical mixed bag. Consequently, under the proposed approach, much of the in-use data ends up being sorted and, in effect, "smeared" across two or even all three of the proposed bins. One consequence of that smearing of results is that the binned data will have limited correlation to any emissions standard that might be applied to the "separate" bins, which undermines the rationale for applying separate regulatory standards to the "separately"-binned emissions data.

WVU's analysis demonstrates the degree to which the 3B-MAW approach can randomly assign data to the 3 "operational" bins. In the graph below from their report, WVU shows how often single data points fall into two or even three bins over the course of a test day, as assessed for the various vehicle categories included in WVU's 100-vehicle test program.[11] The percentage ranges shown for datapoints in one or more "bins" for a given vehicle category represent the range of individual test-day outcomes for all vehicles in the category. The chart that accompanies WVU's graph shows that, in the aggregate, more than 26% of the measured datapoints end up in two bins at the end of the accumulated test-days. That level of cross-binning of data demonstrates that the 3B-MAW protocol does <u>not</u> effectively sort emissions data according to the targeted binned engine-operating normalized-power characteristics.

[11] WVU's nomenclature often refers to the three bins this way: "Bin 1" is the idle bin, "Bin 2" is the low-load bin, and "Bin 3" is the medium/high-load bin.



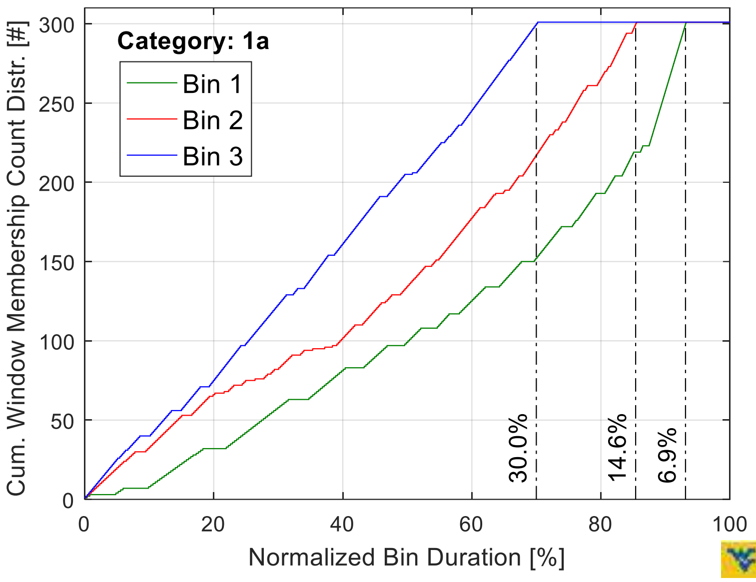
WVU 3B-MAW Report: Percentage count of single data points appearing in either none (i.e., excluded), 1, 2 or 3 bins at the same time for all vehicle categories evaluated.

WVU 3B-MAW Report: Average percentage count per vehicle category of single data points appearing in either none (i.e., excluded), 1, 2 or 3 bins at the same time; global mean represents average across all vehicle categories.

Distribution of Data-points	Mean of Distributions [%]									Global Mean
[-]	1a	1b	2a	3a	3b	4	6a	6b	7a	[%]
Excluded Data (Part of 0 Bins)	12.66	22.61	23.15	12.19	11.23	15.20	7.73	29.33	13.68	16.42
Data-points Part of 1 Bin	58.94	46.03	57.85	52.57	58.95	56.96	54.07	45.55	69.49	55.60
Data-points Part of 2 Bins	26.15	29.75	18.56	32.97	29.54	24.94	36.31	24.58	16.56	26.60
Data-points Part of 3 Bins	2.25	1.62	0.44	2.27	0.28	2.90	1.89	0.54	0.28	1.38

Another very important consequence of the overlapping window approach is that while some measured datapoints will be included in the data set of a particular bin up to 300 times, other points will be included only once, and other data points anywhere in between. That has the effect of variably weighting individual datapoints in the dataset as a whole, and especially within a given bin. The fact that some datapoints can have up to 300 times greater influence on the averaged bin emissions – most acutely at the start of a vehicle's work day when the emissions system may not be fully warmed up – is not consistent with with a fair compliance assessment protocol.

WVU depicts this variable weighting phenomena in the figure below, which indicates the number of times individual data points are used in each of the 3 bins after a shift-day of line-haul vehicle operation. (To understand how to interpret the graph, consider Bin 2: approximately 40% of the datapoints are used 100 or fewer times, 85.4% are used less than 300 times, and 14.6% are used 300 times.) Again, this does not seem to be a fair way to weigh in-use emissions data.



WVU 3B-MAW Report: Cumulative count of window membership of individual datapoints for the three different bins over the normalized shift-day route for a single vehicle of category 1a; data represents a single day of operation.

EPA acknowledges the importance of variable datapoint weighting in the draft RIA. In section 2.2.3.2, EPA writes:

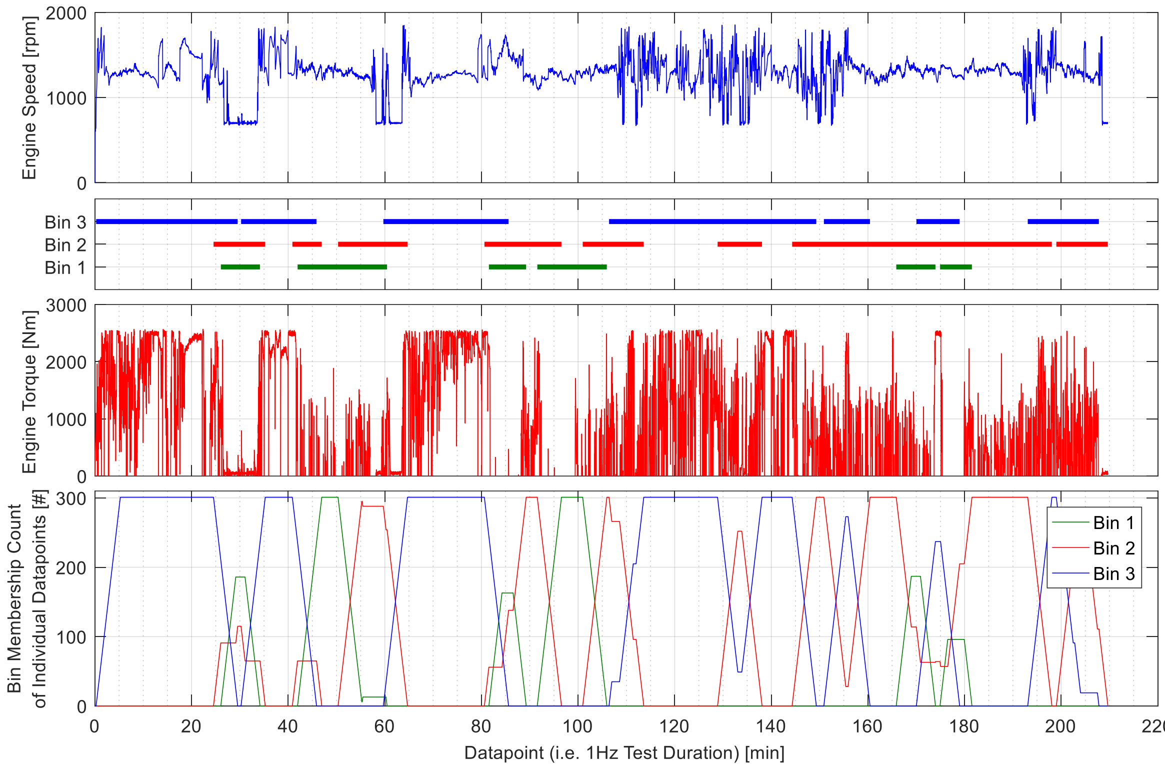
> In what we believe to be an improvement to a work-based window, we are proposing a moving average window (MAW) approach consisting of time-based windows. Instead of basing window size on an amount of work, the proposed MAW includes a window size of 300 seconds. The time-based windows are intended to *equally weight each data point* collected. [*emphasis added*]

Later in section 2.2.3.4 of the RIA, EPA considers data point weighting as justification for their proposal regarding concatenating data over excluded data segments. Here, EPA writes:

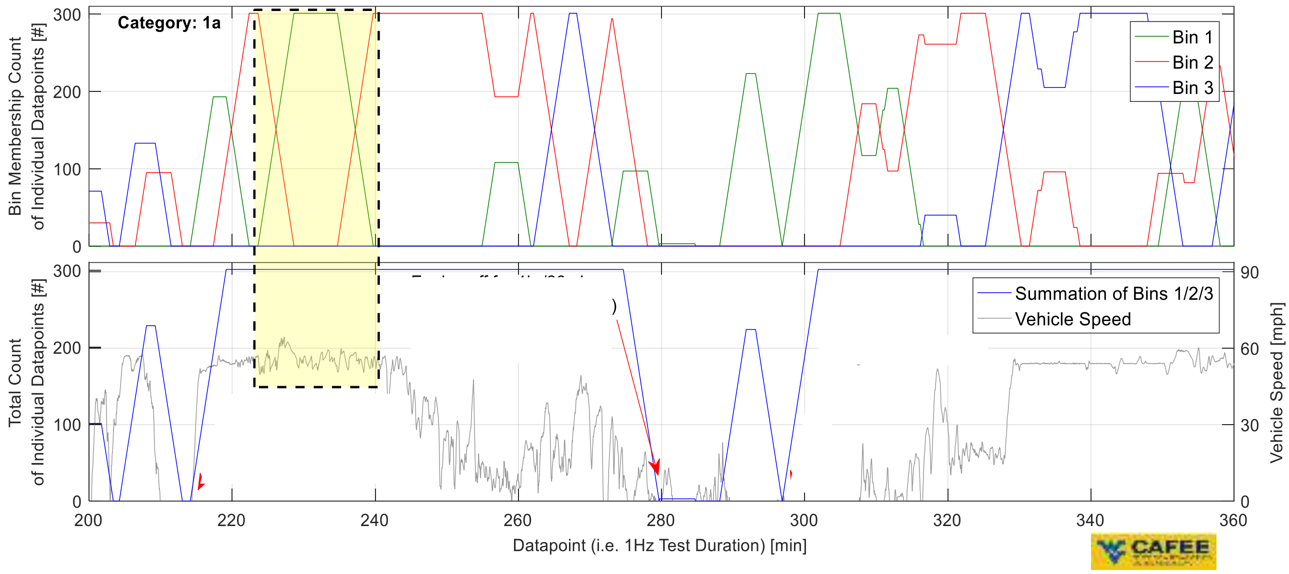
> Except for the data points as the beginning and end of the test and those around long data exclusions, this methodology *equally weights emissions at each data point* during the in-use testing. We believe this is appropriate, as the under-weighted data points consist of a small percentage of the HDIUT data, which contain a minimum of 10,800 1-Hz data points. [*emphasis added*]

EPA underscores the importance of equal data point weighting in both of those instances, but fails to consider arguments regarding unequal data point weighting in the instance where it matters most – in the accumulated 1Hz data within any bin where compliance judgments are made.

WVU has broken down the bin placement of data over an almost 4-hour segment of the CARB NTE Southern Route. The second graph in the figure below depicts the bin placement overlap (where bins overlap, and data is being distributed with unequal weighting in the bins), and the fourth graph tracks how many times individual data points are being used in each of the 3 bins. With every transition from one bin to the next, there is a slow walk of uneven data point weighting. In this data segment of less than 4 hours, there are no less than 13 bin transitions, where a transition culminates into finally achieving equal datapoint weighting in a bin (300 times per data point). It is important to point out that these 13 transition observations are without regard to all of the "partial" transitions where the 300x equal data point weighting goal is not even reached before the transition reverses due to a change in engine load. These data clearly shows a major departure from the equal data point weighting objective. Thus, EPA's emphasis on the value of equal data point weighting falls apart under this analysis, revealing overlapping windows as one of the more serious flaws of the 3B-MAW protocol.



The additional graphs below from WVU's report represent approximately 6 hours of data from a line-haul truck (EMFAC category 1a). The upper graph depicts the number of times individual data points (any point along the X-axis) are placed into Bins 1, 2, and/or 3. Based on those data, WVU concludes that it is "obvious from [the figures] that transitioning between different bins results in un-equal weighting of an individual data point in a given bin," which could undermine the objective to regulate in-use emissions in a reasonable and representative manner.

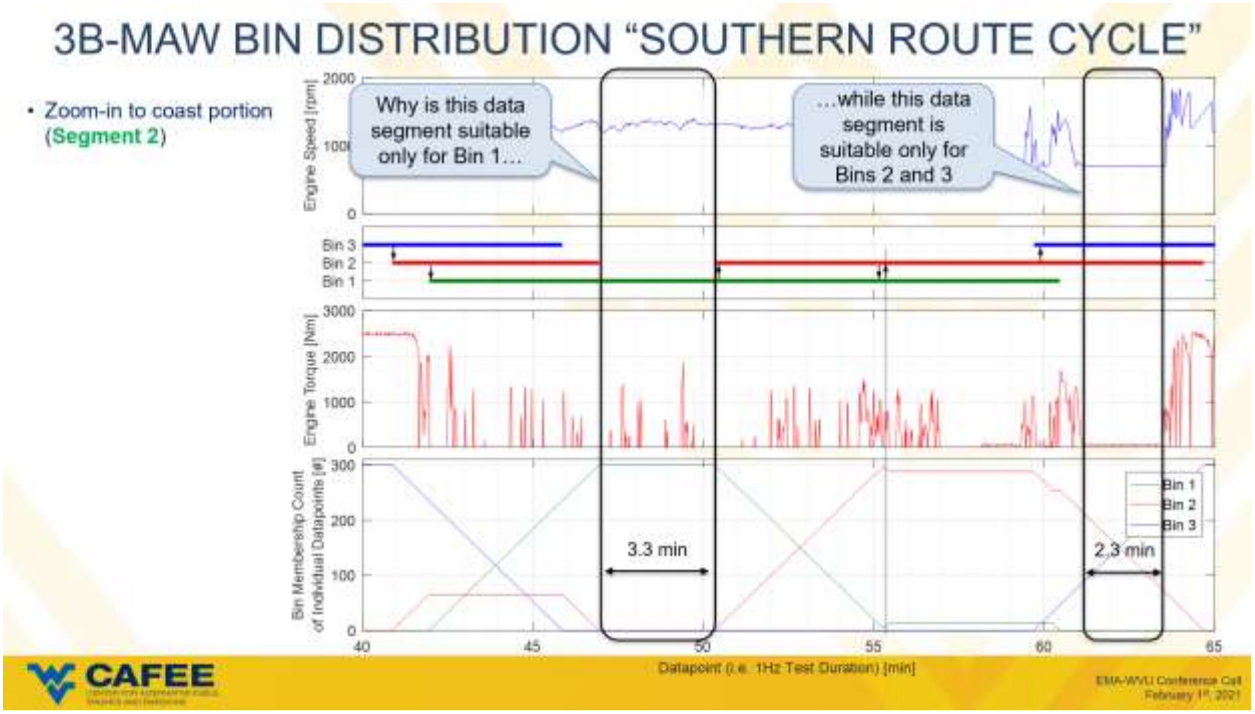


WVU 3B-MAW Report: Bin membership count of individual datapoints to either of the three bins for a category 1a vehicle (i.e., long haul); data taken from a single day of operation.

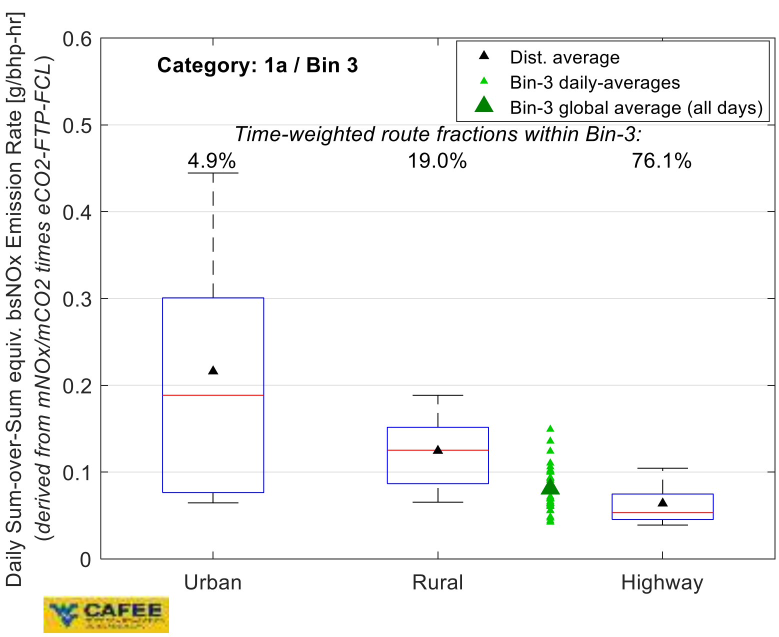
The fundamental problem with this highly variable data point weighting system is that within a bin, when assessing emissions against a bin standard, some data segments (e.g, 20 seconds of data) will be given 10, 20, even 30 times more weighting in the compliance assessment for that bin than other 20 second stretches of data. While EMA has shared this concern with EPA multiple times, the Agency has not even tried to address the issue.

WVU also highlights (in the yellow shaded area in the figure above) a period of 55 to 60 mph sustained highway speed over a period of about 17 minutes. Illogically, the 3B-MAW protocol places the majority of this operation in the idle bin (demarked by the green line). As WVU states, "It is clearly evident from the vehicle speed trace that this type of operation is definitely not typical idle operation that should be compared to the idle emissions standard."

Another example of illogical data placement is presented in the data WVU has captured on a line haul vehicle below. Two segments of data are worthy of note in this test. The first is a 3.3 minute stretch of 55 to 60 mph crusing data, for which all datapoints are included in windows that are placed solely in Bin 1, the "idle" bin. Some 15 minutes later in the same test trace is a 2.3 minute data segment of curb idle operation, for which all data points are included in windows that are placed only into Bins 2 and 3, the "low power" and "medium/high power" bins.



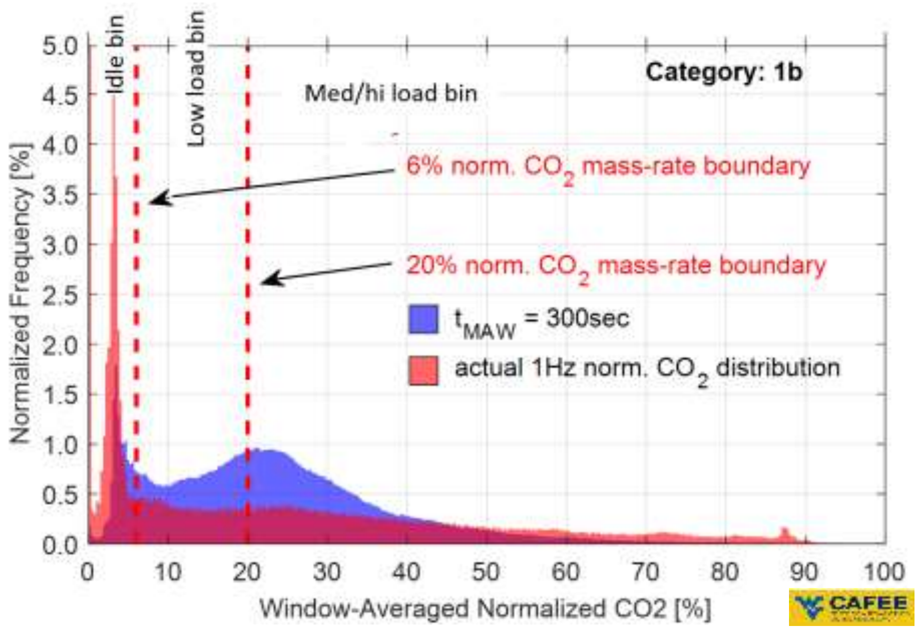
In another assessment of whether the proposed 3B-MAW approach effectively segregates emissions data according to engine-operation characteristics, WVU analyzed the medium/high bin (Bin 3) windows from multiple days of testing of a single line-haul vehicle, and separated those data into three ranges of vehicle speed: urban (≤31 mph), rural (>31 and ≤ 46.6 mph), and highway (> 46.6 mph). WVU's graph below shows the variability in day-to-day emissions results from the three speed ranges within Bin 3, the supposed medium/high bin. Clearly the lower speed ranges of the urban cycle produce overall higher emissions results than the higher speed ranges, and show much greater variability from one day to the next. Thus, there are factors in play that have a more significant effect on the level and variability of in-use emissions than the normalized-power-based bin boundaries that EPA has borrowed from CARB.



WVU 3B-MAW Summary: Bin-3 emissions for a single shift day of a category 1a vehicle divided into urban, rural, highway operation based on MAW-averaged vehicle speed; urban (≤31mph, rural >31 & ≤ 46.6mph, highway > 46.6mph).

Significantly, none of the WVU analyses concerning the problems with the proposed 3B-MAW approach, with the exception of the vehicle speed breakdown in the medium/high load bin, has anything to do with specific tailpipe emissions levels or low-NO_x technologies. Those results (and problems) would bear out, and the resultant concerns hold true, regardless of whether the analyses involved assessments using today's emisions control systems, enhanced emissions control technologies, or even EPA's Stage 3 RW prototype. Thus, the concerns with the 3B-MAW approach will be present no matter which low-NO_x technologies are envisioned.[12]

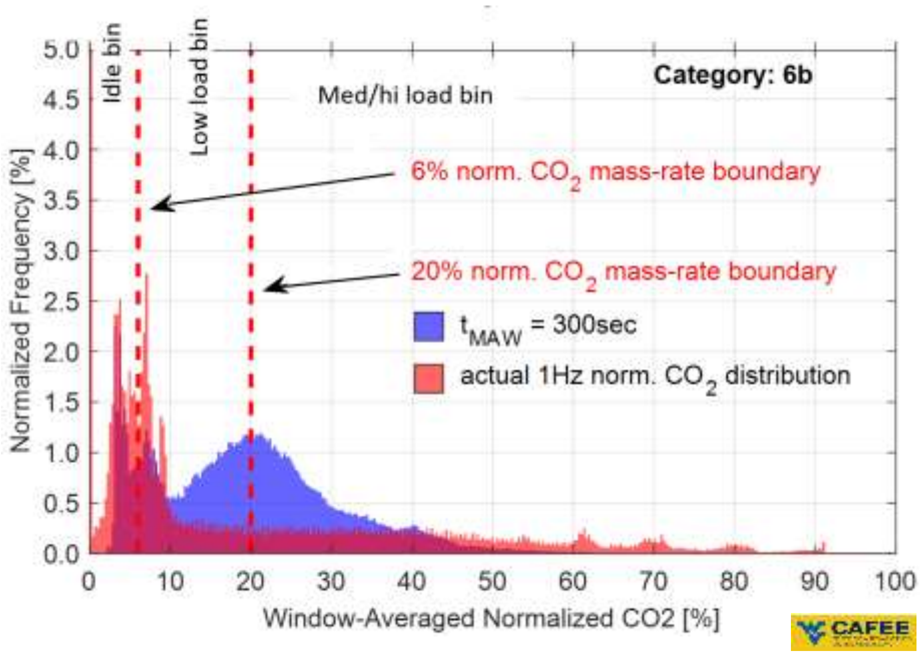
Perhaps the most compelling analysis in the WVU Report is a series of figures showing the real-time percentage of operation at normalized CO_2-rate data points compared to how the 3B-MAW method distributes those same data into the three bins. The figures below break that information down for each of the vehicle-types that WVU tested. As depicted below, the 3B-MAW process distorts the vehicles' true operating characteristics, capturing and redistributing the data in a way that simply does not match the reality of the vehicles' actual operations on the road. The actual real-time second-by-second operation of a category 1b short-haul vehicle, for example, exhibits predominantly idle and very light load operation with a relatively flat distribution of data at low levels of frequency across the rest of the normalized CO_2 rage. Compare that true 1Hz operation (in red), however, with the 300-second 3B-MAW windowing process distribution in blue, which shows the same vehicle as having a strong peak of operation at the boundary separating the low and medium/high load bins, an operating profile that clearly and markedly differs from reality.



WVU 3B-MAW Summary: Window-averaged (w/ t_{MAW} = *300sec*, blue dist.) vs. actual 1Hz (red dist.) normalized CO_2 mass rate distributions for category 1b (<u>i.e.</u>, short haul) vehicles.

Similarly, comparing real-time and 3B-MAW distributions of data for a more vocational vehicle application, such as a category 6b food/beverage delivery vehicle, results in a distortion of data that is even more apparent.

[12] WVU's Report, **Exhibit "A"** hereto, contains a more detailed explanation and demonstration of each of the multiple flaws inherent with CARB's unverified and untested 3B-MAW protocol.

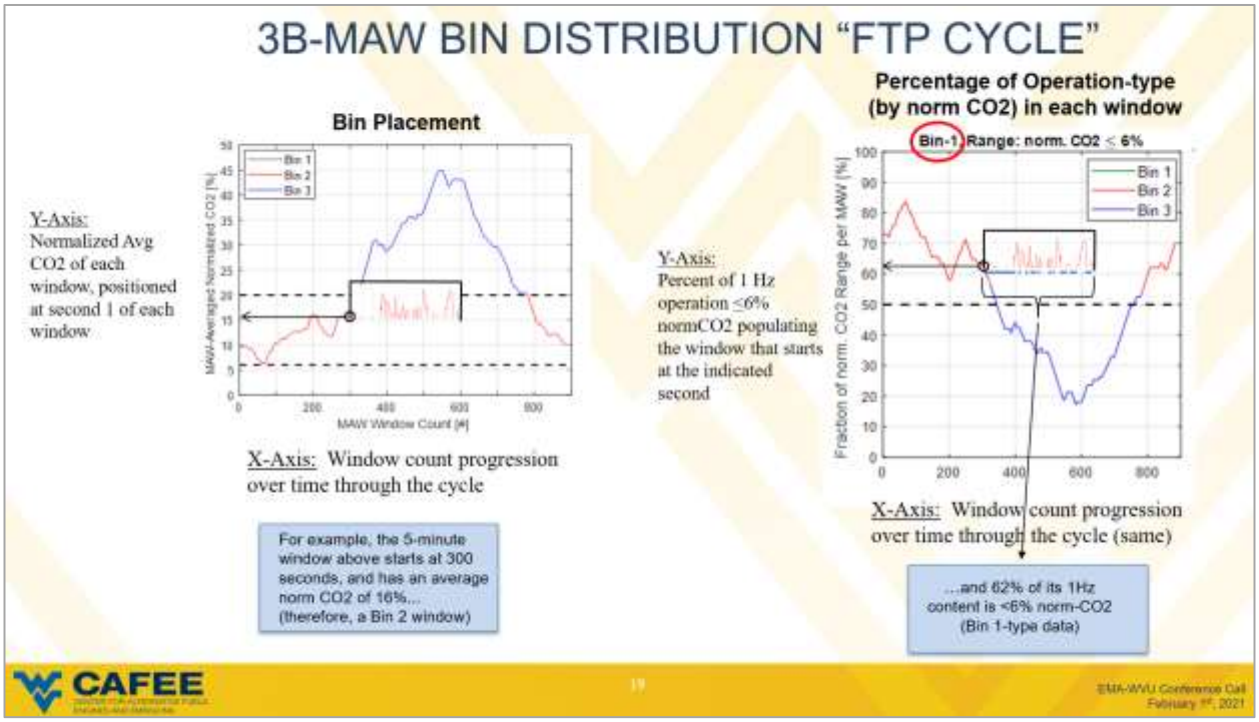


WVU 3B-MAW Summary: Window-averaged (w/ t_{MAW} = *300sec*, blue dist.) vs. actual 1Hz (red dist.) normalized CO_2 mass rate distributions for category 6b (i.e., food/beverage distribution / moving/ towing, T6 interstate heavy) vehicles.

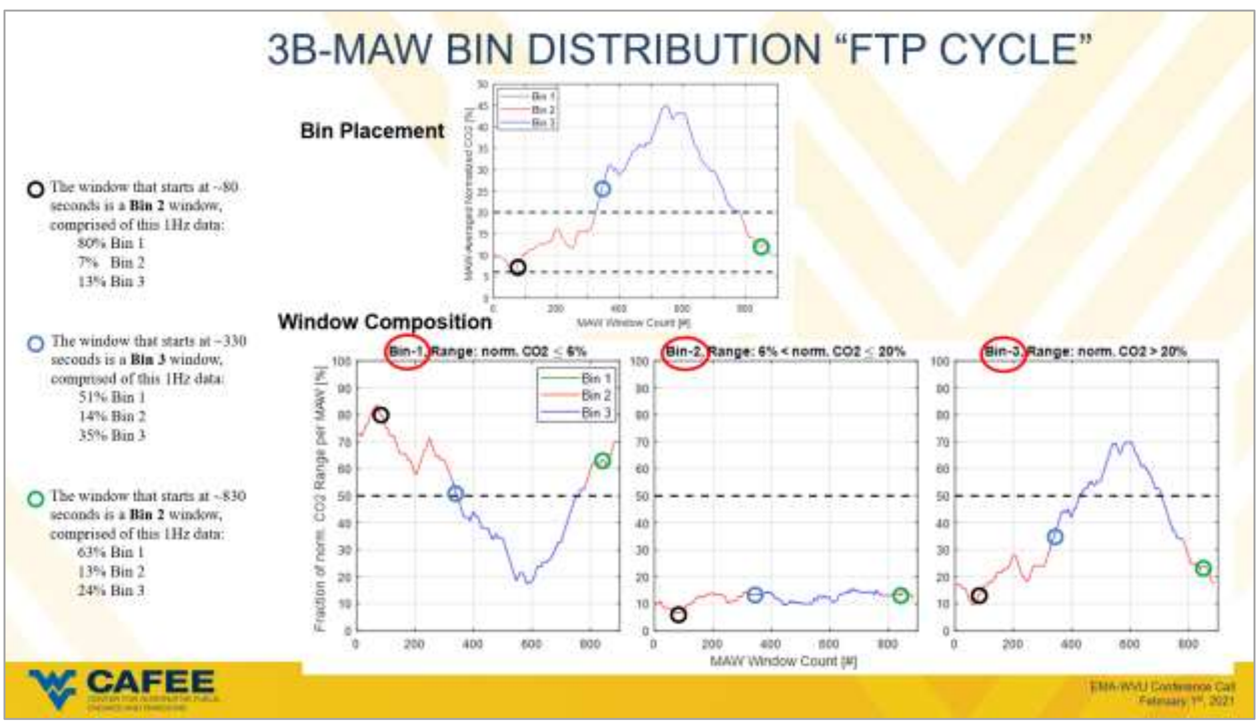
Another concerning aspect of the binning process that WVU has analyzed is presented in the following graphics. The basis for the analysis is represented in the two graphs below, which depict the bin placement of the first second of each valid 3B-MAW window when deployed over the FTP cycle. Each data point in the graph is the first data point of a 300 second 3B-MAW window. The horizontal dashed lines represent the bin boundaries (6% and 20%), and the y-axis position of each data point reports the *average* normalized CO_2 level for the window that starts with that 1Hz data point. As shown, the first approximately 300 seconds of the FTP cycle is initiating windows that fall into Bin 2 (between 6 and 20% normalized CO_2). Window placement then transitions into Bin 3 where the line turns blue (though the transition takes 5 minutes in total before all data points in those Bin 3 windows have normalized CO_2 levels greater than 20%). The windows eventually fall back into Bin 2 over the last portion of the cycle.[13]

The graph to the right is specific to data that falls into Bin 1 when the FTP cycle is processed through the 3B-MAW protocol. Recalling that any window can be comprised of individual data points with widely varying average normalized CO_2 levels (or, practically speaking, average power levels), we can see in the graph at right, for Bin 1, the percentage of the 1Hz data points that were at ≤6% normalized CO_2 (that is, were representative of what EPA calls Bin 1 operation). The percentage of data points in each window that were at Bin 2 and Bin 3 normalized CO_2 level can be similarly reported.

[13] The FTP cycle is 20 minutes, or 1200 seconds long. The graphic stops at 900 seconds, because it reports data on the basis of the *first datapoint* of each window. After 900 seconds, no new 300 second windows are completed (are valid). The last valid window is the one which has its first second of 1Hz data at 900 seconds.



With that explanation of the analysis technique, the next graphic indicates the compositional breakdown of three 3B-MAW windows recorded during the FTP cycle.

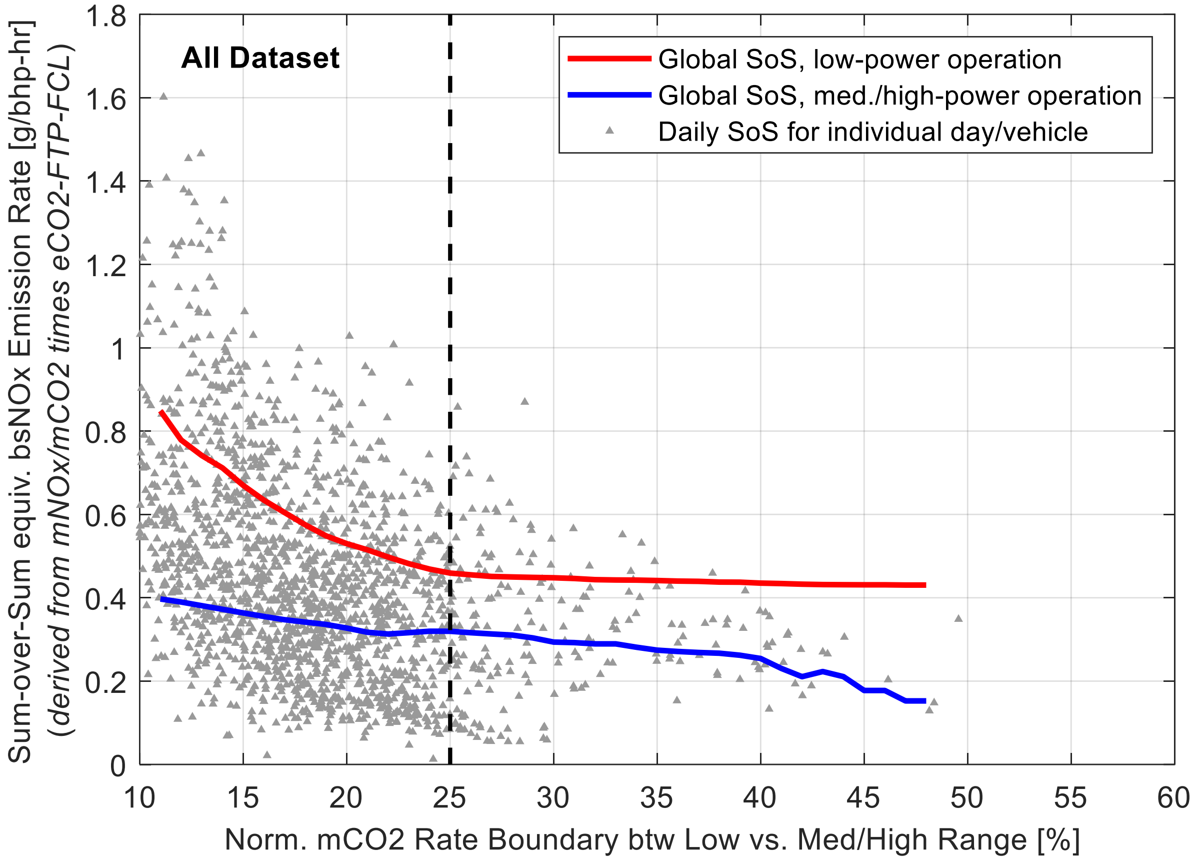


The first window selected for consideration (where the first 1Hz data point is circled in black in each of the graphs above), is a window that, by the 3B-MAW process, was placed into Bin 2 (as can be seen in the upper graph). That window is comprised of 300 data points, 80% of which are $\leq$6% normalized CO_2 (and so representative of Bin 1 operation), 7% of which are between 6 and 20% normalized CO_2 (representative of Bin 2 operation), and 13% of which are greater than 20% normalized CO_2 (represntative of Bin 3 operation). Remarkably, this window, which was placed into Bin 2 (and judged against the Bin 2 standard), has a mere 7% of its 1 Hz data points coming from operation that EPA has determined to be "Bin 2" operation. The other two data points isolated for consideration (circled in blue and red in the graphic above) demonstrate similar gross imbalances in operational representation relative to bin placement when 3B-MAW is applied to the FTP cycle. A similar analysis of the LLC cycle evaluated by the 3B-MAW technique reveals similarly counter-intuitive outcomes (the window initiated at 3400 seconds falls into Bin 2, despite that fact that only 9% of the 1Hz data points are recorded at normalized CO_2 levels within the 6% and 20% Bin 2 boundaries.) Clearly, this analysis shows that 3B-MAW is not a logical, reliable system for binning emissions, and, therefore, not a legitimate, representaitve system for setting and enforcing in-use standards.

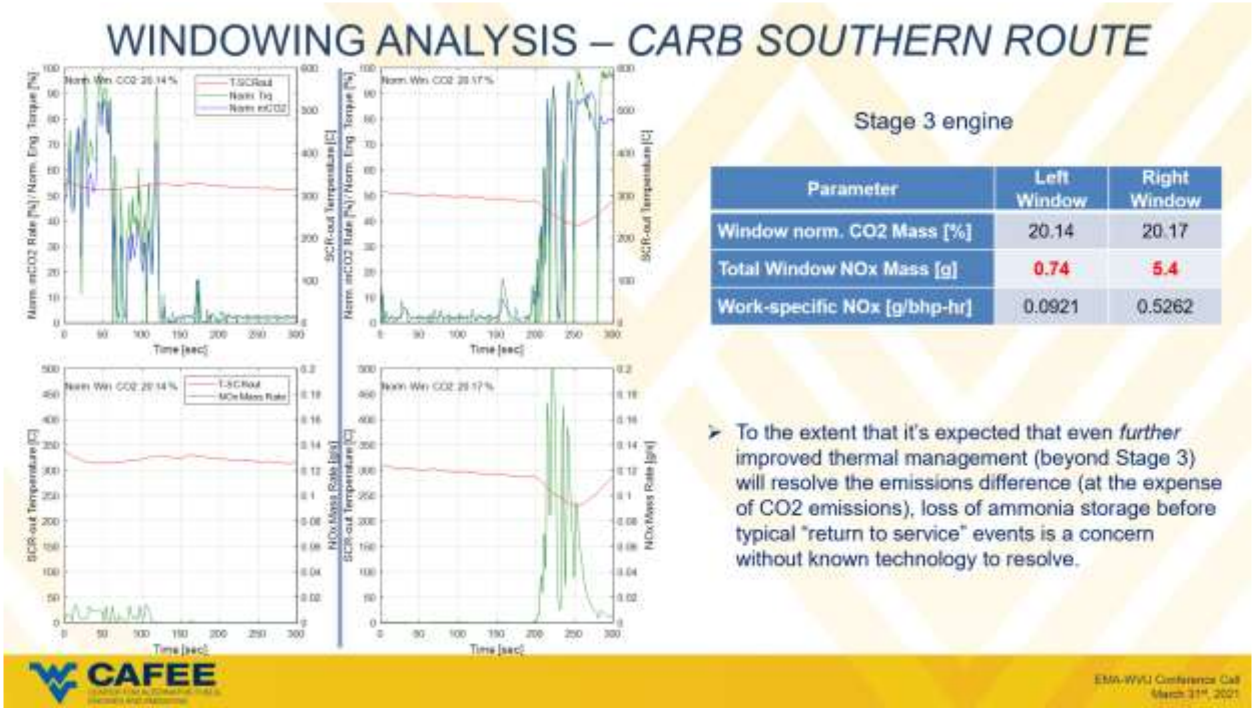
When considering the results of the above analysis, it is important to point out that the FTP is not a "one-off" cycle rarely represented in real world operation. Indeed, the FTP has been the cornerstone of emissions demonstration cycles for more than four decades. Moreover, this imbalance in bin composition will play out in every real world duty cycle. It is also very telling that the FTP cycle, 41% of which, on a time bais, is comprised of idle operation, produces *not a single idle bin window* when evaluated using the 3B-MAW protocol. That simple fact alone raises serious concern about the validity of the protocol, which has not been validated by even a single minute of real-world chassis testing.

Based on the foregoing, WVU has concluded that the "proposed bin boundaries are misaligned with actual in-use vehicle operations." EMA fully agrees with WVU's assessment. Accordingly, significant revisions to EPA's proposed 3B-MAW protocol are required.

If EPA maintains the 3B-MAW approach in the final rule, which EMA opposes, EMA recommends that the 20% normalized CO_2 boundary between Bins 2 and 3 be increased to 25%. EMA bases this recommendation on the emissions characteristics of the 100-vehicle testing conducted by WVU in Southern California. Examining the sum-over-sum emissions characteristics of the fleet is informative. The graph below shows the average sum-over-sum emissions of the fleet as a function of the average normalized-CO_2 level for each recorded shift-day. The red line indicates the average NO_x emissions of all vehicle test-days where the average normalized CO_2 level was *less* than the x-axis value. The blue line indicates the average NO_x emissions of all vehicle test-days where the average normalized CO_2 level was *more* than the x-axis value. An inflection point in the low average normalized CO_2 level data (the red line) is clearly evident at 25% normalized CO_2. Accordingly, EMA recommends that the 3B-MAW boundary between the low-power bin and the medium/high power bin be established at 25% normalized CO_2 in lieu of the proposed 20% level.



All of the analyses above raise the fundamental question of why EPA is proposing to process data in overlapping windowed segments. Both EPA and CARB have argued that capturing data in windowed segments permits data to be evaluated, at least in part, on the basis of a segment of operating "history." That argument appears to be reasonable, because the efficiency of the most effective NO_x reduction tool, SCR, is dependent upon the catalyst temperature, and therefore the "recent history" of the exhaust temperature profile. The problem with that argument, however, is that the 3B-MAW protocol actually makes no distinction whatsoever regarding the characteristics of engine-operating history within any given window. A window's bin placement, and therefore its linkage to any relevant in-use standard, is based *solely on the average normalized CO_2 level* (effectively the average power) of that window, without any consideration of the "history" that purportedly compelled EPA to "window" emissions data in the first place. Two windows can end up having mirror-image time traces (engine speed, torque, etc.), one with rising SCR temperature, the other with falling SCR temperature, which can certainly yield very different emissions results. An example of this phenomenon, represented with actual data recorded by WVU, is captured here:



Notwithstanding the clearly different emission results, the 3B-MAW protocol would bin those two differing windows identically, and hold them to the same in-use emissions standards. Consequently, while EPA's rationale is that engine operating history is important, the 3B-MAW protocol does nothing to account for the particular details of that operating history, and therefore completely undermines the "operating history" rationale for the Agency's proposal.

The fact that windowing data serves no useful purpose could perhaps be tolerated if the new in-use protocol also did not raise the other concerns at issue, including imbalanced data point and data segment weighting, and illogical bin placement that is disconnected from any vehicle's actual duty-cycle. Yet despite EMA's repeated demonstrations of the need for revisions to the 3B-MAW protocol – again, a protocol that EPA simply copied from CARB – EPA has simply refused to engage on those important issues. In particular, EPA staff have rejected out-of-hand EMA's proposal to adopt a much more straightforward, more representative view of emissions impacts through a "sum-over-sum" approach to assessing a day's emissions performance. Therefore, later in these comments, EMA will make specific recommendations for revising and improving upon the proposed 3B-MAW protocols.

c. Return-to-Service events present major compliance risks under the 3B-MAW protocol

Other problems with the proposed binning proposal become evident when the new Low Load Cycle (LLC) certification test is processed according to the 3B-MAW in-use protocol. A significant number of windows, especially those including long periods of idle followed by a high-load "return to service" period of operation, end-up in the medium/high-load bin. Consequently, the portions of the LLC most vulnerable to NO_x "breakthroughs" would have to comply with the in-use standard linked to the more stringent FTP/RMC standards, not the higher LLC standard. More specifically, those LLC windows which would fall into the medium/high load bin would have to meet an Option 1 standard of 0.030 g/bhp-hr, established on the basis of the FTP/RMC standard multiplied by the conformity factor (1.5). If a vehicle is in a generally low-load application, a long idle period followed by a high-load return to power could be the only, or otherwise dominant, operating condition where data is placed into Bin 3, putting the in-use test at high risk for a non-compliance determination. The high (and potentially unfair) risk of noncompliance would stem from the fact that the limited amount of Bin 3 data would be the exact type of data that most likely would not meet the Bin 3 standard.

The issue of return-to-service events unduly impacting Bin 3 NO_x emissions is exacerbated by conditions where the return-to-service emissions are generated shortly after a cold start. On occasions where a vehicle is started for the first time in the day, or started after an extended key-off condition on a cold day, and soon after enters into a high-load condition, those emissions could almost exclusively be placed into Bin 3. It would take a considerable amount of Bin 3 operation under fully warmed operating conditions to dilute the cold start emissions to a level compliant to the very stringent Bin 3 standard. There can be no guarantee, of course, that sufficient operating time will accumulate in Bin 3 to do so. To address this issue, EMA recommends that EPA include a process to avoid accumulating cold-start emissions in the very stringent Bin 3. Cold-start engine conditions are associated with low SCR core temperatures, which are more representative of EPA's goal to segregate Bin 2 low-load emissions. Cold-start emissions therefore should be held to the Bin 2 emissions standard. EMA recommends that all Bin 3 windows recorded when the coolant temperature is less than 70°C at any point in the window should be placed in Bin 2 instead of Bin 3. The coolant temperature threshold of 70°C is consistent with CARB's cold operation exclusion applicable to MY 2024 through 2026 engines, and is a reasonable threshold to apply in this case.

The cold-start emissions profile is one that requires serious consideration. If EPA were to adopt a modified version of 3B-MAW, for example, the proposal that EMA details in subsections h. and i., below, the Agency would need to consider alternative methods to accommodate the very high emissions that would result if the engine were heavily loaded shortly after restart. This is especially true for a vehicle that may be stopped for prolonged periods of at least 30 minutes, 2 to 3 times or more per day. If the aftertreatment cools to levels unsupportive of NO_x conversion, the initial NO_x emissions surge could be impossible to recover from over the course of the remainder of the day's operation. This problem becomes even worse under conditions approaching EPA's minus7^{o}C proposed ambient temperature threshold. One approach to limiting the impact that cold-start emissions can have on the NO_x compliance assessment is to limit the effective "weighting" that cold-start emissions can have in any bin. That would involve mathematically ratioing-back the time-based or work-based content of the cold-start emissions in the bin to some maximum regulated level. That would permit capturing and using all the data, but without unduly jeopardizing the compliance assessment because the day's operation included multiple cold-starts, potentially even in cold ambient conditions.

In that regard, the total impact of cold-start emissions associated with EPA's Stage 3RW engine and aftertreatment have barely been evaluated during this rulemaking. The FTP compliance evaluation with the Stage 3 engine only included a cold-start from 20 to 25^{o}C. (tellingly, that cycle generated a non-compliant result, measuring 0.022 g/bhp-hr, so it is clear that there is little room for compromised NO_x control due to cold starts from even colder temperatures.) The few tested road-cycles included cold-start operation, but again, never at temperatures less than the engine-dyno 20 to 25°C range.

This discussion of cold ambient operation brings us back to the fundamental question of the technical feasibility of the proposed standards. The NPRM has been drafted without any testing experience in cold ambient conditions. But, as mentioned, EPA is requiring compliance down to minus-7°C. The Stage 3 engine has demonstrated only marginal or even non-compliant results over the 3B-MAW test protocol under the favorable test cell conditions. There is absolutely no on-road experience with this technology package, leaving it without any evaluation in cold ambient conditions at minus-7°C. In addition, EPA has no plans to conduct any testing under those extreme ambient temperatures before the regulation is finalized. In the absence of any direct evidence of how EPA's stringent requirements will be impacted by cold ambient conditions, it is imperative that the Agency provide protections from non-compliance determinations under those types of conditions. Accordingly, *EMA recommends that EPA include a coolant temperature exclusion threshold of 20°C.*

Maintaining compliance to the very stringent NO_x standards that EPA is proposing all the way down to minus-7°C (20°F) ambient temperatures would require aggressive thermal management strategies to maintain exhaust temperatures conducive to high SCR NO_x-conversion efficiency. Aggressive thermal management strategies under those very cold conditions (minus-7°C, or 20°F) will lead to high levels of CO_2 emissions as the controls work to heat the SCR. Those high CO_2-emitting strategies will be active under cold ambient conditions where ozone formation does not even occur. The Agency should seriously consider whether the minus-7°C compliance threshold is striking the right balance in the CO_2/NO_x tradeoff. EPA should consider increasing the ambient temperature exclusion to a level closer to where ozone formation might be expected. Such a revision in the final rule would avoid the need to deploy high GHG-emitting thermal management strategies during operations in cold ambient conditions when ozone formation does not occur.

Returning to engine cold-start conditions, EPA has proposed to invalidate a test is if the engine coolant temperature at the point of first engine start for the day is more than 30°C (86°F). Such a requirement is overly restrictive, especially given the ambient temperature conditions typical over much of the southern U.S. For example, consider the proposed requirement in the context of the typical in-use test scheduling process. Should a manufacturer cancel all in-use testing for the day because the engine's coolant temperature failed to drop below 30°C during the course of the evening? What judgment is the in-use test team supposed to use to feel confident enough to start the engine and not witness the flow of warmer water resting in the engine block immediately increase to temperatures >30°C as that water flows past the temperature sensor?

Any such outcome would render the scheduling, time, resources and inconvenience to the customer's operations for naught if the test were to be declared invalid as EPA proposes. The Agency should remove the maximum coolant temperature criteria at engine-start, or at least increase it to 40°C to reduce the chances of this kind of wasteful outcome. The additional 10°C lower threshold that EPA proposes adds very little to the representativeness of the test data in terms of assessing compliance to in-use standards. EMA is *not* recommending to eliminate any data in the day's testing by this recommendation. Indeed, we are only recommending a small adjustment to the parameter that would declare a test fully invalid.

d. The proposed CO_2-specific metric creates an unfair advantage for less efficient engines.

The CO_2-specific metric that EPA proposes as the basis for assessing in-use emissions under the 3B-MAW protocol includes a factor in the bin emissions calculation that attempts to "correct" for engine efficiency variances. More specifically, the engine family's certified CO_2 emissions performance over the FTP cycle is included in Equation 1036.515-5 (calculation of emissions for the low-load bin and medium/high-load bin) as shown below:

$$e_{\text{sos[emission][bin]}} = \frac{\sum_{i=1}^{N} m_{\text{[emission][bin]win}i}}{\sum_{i=1}^{N} m_{\text{CO2[bin]win}i}} \cdot e_{\text{CO2FTPFCL}}$$

Eq. 1036.515-5

Where:

i = an indexing variable that represents mass emissions from one window.

N = total number of windows in the bin.

$m_{\text{[emission][bin]win}}$ = sum of mass for each emission for a given window and bin as determined in paragraph (f) of this section.

$m_{\text{CO2[bin]win}}$ = sum of mass for CO_2 for a given window and bin as determined in paragraph (f) of this section.

$e_{\text{CO2FTPFCL}}$ = the FCL value for CO_2 emissions over the FTP duty cycle identified in the engine family's application for certification.

Example:

$N = 15439$

$m_{\text{NOxmediumhighloadwin1}} = 0.546$ g

$m_{\text{NOxmediumhighloadwin2}} = 0.549$ g

$m_{\text{CO2mediumhighloadwin1}} = 10950.2$ g

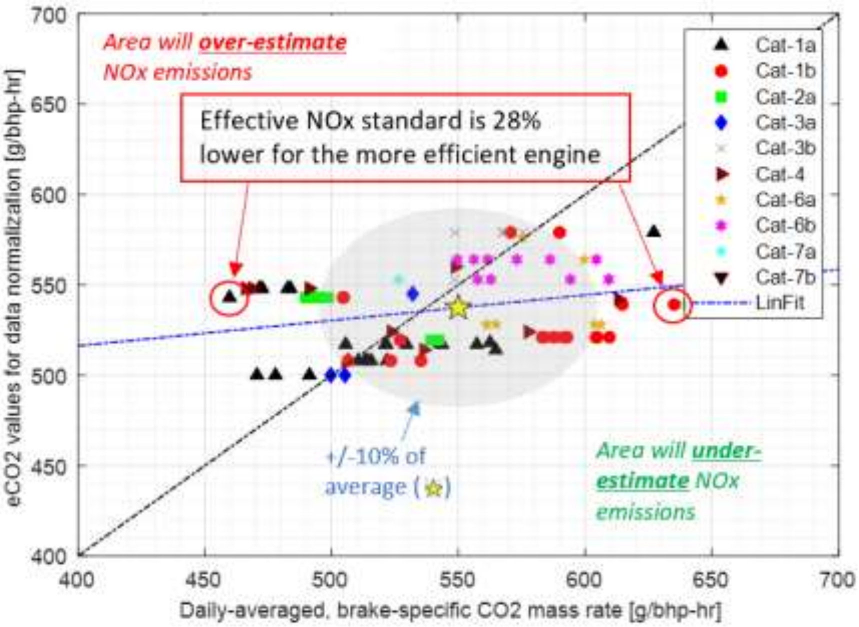
$m_{\text{CO2mediumhighloadwin2}} = 10961.3$ g

$e_{\text{CO2 FTPFCL}} = 428.1$ g/hp-hr

Including the FTP CO_2 correction factor ($e_{\text{CO2FTPFCL}}$) is sensible on its face, because otherwise, reduced CO_2 emissions (from a more efficient engine) accumulated in the denominator would increase measured emissions results for a given amount of criteria emissions accumulated in the bin. Multiplying that result by the certified CO_2 emissions performance of that engine family would, in theory, inversely reduce the net emissions result, correcting for this issue. ("Efficient" engines having lower FTP CO_2 levels generate reduced bin emissions, all other things being equal.) Unfortunately, the FTP CO_2 emissions result is not necessarily an accurate assessment of the in-use CO_2 emissions from an engine. Indeed, it can be quite inaccurate for this purpose.

To demonstrate this point, we turn to additional WVU analysis of the 100 vehicle SoCal test fleet[14]. In the plot below, each data point represents a single vehicle's performance over approximately 20 to 30 days of testing. The graph compares actual in-use CO_2 emissions (in g/bhp-hr, as would have been accumulated in Bin 2) to the certified FTP CO_2 emissions used as the correction factor in Equation 1036.515-5. (The category breakdown is a reference to the various EMFAC categories under which each vehicle application falls).

[14] WVU presentation, "eCO_2 vs bsCO_2 comparison for FTP/RMC-FCL;" April 21, 2022.



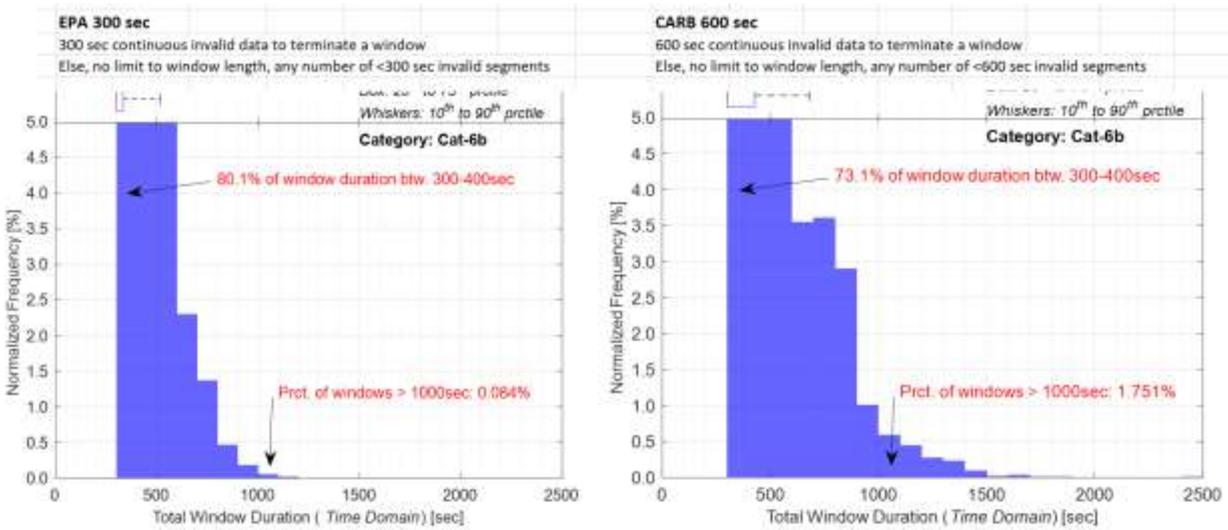
Examining the two circled vehicle data-points, we have an example where the Category 1a vehicle and the Category 1b vehicle have very similar certified $e_{CO2FTPFCL}$ levels (shown as "eCO_2" on the y-axis), yet very different average in-use CO_2 emissions over the 20 to 30 days each was tested (as plotted on the x-axis). So, while Equation 1036.515-5 uses the certified FTP CO_2 value for each of those engines to "correct" for their inherent efficiency characteristics, the reality is that the more efficient Category 1a engine (the more environmentally favorable engine) would have to accumulate 28% less NO_x in the bin (per unit work) to generate emissions results equivalent to those of the less efficient Category 1b engine. Said another way, the more efficient engine in the real-world example above would effectively be held to a 28% more stringent emissions standard. That would be true for all of the criteria emissions constituents. This is an inherently unfair consequence of the in-use emissions protocol that EPA proposes. The fact that the data plotted above was not tested with Stage 3 low-NO_x technology or equivalent has absolutely no bearing on the unlevel and unfair outcome described here. One approach to address this issue could be to reconsider the use of broadcast torque to determine work for bin placement and emissions calculations, instead of normalizing by CO_2 and scaling by FCL.

e. EPA should limit the maximum window duration when applying concatenation criteria

The proposed provisions at 1036.515(b)(3) relate to managing window concatenation when invalid data segments are recorded. Those provisions specify that a window cannot close unless more than 300 *continuous* seconds of invalid data are encountered. Otherwise, the window must continue to accumulate data until 300 seconds of valid data are captured to close the window.

Careful management of the procedures regarding concatenation is very important, as an analysis of the WVU 100-vehicle Southern California fleet data shows. EMA supports EPA's decision to reduce the 600s continuous invalid data criteria that CARB finalized in their Omnibus regulation to 300s. When WVU examined the impact of this change on tests of EMFAC Category

6b vehicles (Heavy towing/moving),[15] the improvement in maximum window length is significant, as seen here:



It makes no sense to allow windows to be open for extended periods of time, as much as 1000s (16 minutes) or more, when any connection that may actually exist between operational characteristics and emissions rates (according to EPA's own arguments) is completely lost. The longest window duration WVU observed when using the 300s continuous invalid data criteria is 1976s (more than 30 minutes). That is far too long. EMA supports the adoption of the proposed 300s concatenation criterion, but recommends that EPA limit that maximum size of any window to 900s (three times the nominal window length).

EPA appropriately proposes to exclude data that includes regeneration events (§1036.515(c)(3)). EPA should also provide an exclusion for windows accumulated for a period of time after the regeneration event is complete, to allow emissions control to be restored in a way similar to that provided for in proposed §1065.680. The SAE J1939/J1979 standards may require updating to support this proposal

f. EPA's proposed compliance factors could be unreasonable

EPA's proposed implementation of the 3B-MAW approach also includes the establishment of an in-use multiplicative conformity factor of 1.5 that links each of the three bins to a unique test-cell standard. But EPA has not demonstrated that the uniform 1.5 conformity factor was reasonably derived from an analysis of the three separate bins of NO_x data, or is based on any independent assessment of technical feasibility. Nor has EPA demonstrated whether an additive rather than a multiplicative approach would be more appropriate. In that regard, and as discussed further below, the in-use conformity factor also needs to be assessed against the limits of detection of the instruments that will be used to assess in-use compliance. EPA's proposal of a 10% NO_x accuracy margin is neither sufficient nor adequately data-driven. These factors are addressed in more detail in the technical feasibility section of these comments.

[15] WVU analysis, "Summary Results – 3B-MAW – Window Size Analysis CARB vs EPA;" April 1, 2022.

EPA envisions that the 3B-MAW protocol will assess emissions performance for all or almost all of a HD engine's operation over its entire shift-day. Indeed, that expectation is one of EPA's primary objectives in implementing a new in-use protocol, given the relatively limited coverage of in-use operations provided by the current NTE method. EMA agrees with that objective. The NTE protocol was often problematic for manufacturers as well, because if there were only a handful of NTE events recorded over a vehicle's in-use test day, just one NO_x breakthrough event could mean failing to meet the minimum NTE-based "pass" ratio. Despite EPA's intent, however, a similar risk exists still with the 3B-MAW protocol. A day's testing may very well capture 99% of the vehicle's operating time, yet, depending on the duty cycle, any single "bin" still may have a minimal amount of in-use emissions data stored for assessment. Consequently, EMA supports including a minimum data requirement for each bin, expressed as a number of windows, or total operating time, or a similar metric.

EPA's proposal is to require a minimum of 2,400 windows in each of the 3 bins. When conducting an in-use test, if a day's testing does not accumulate at least 2,400 windows in each bin, the manufacturer must test for as many additional days as necessary to accumulate at least 2,400 windows in each bin. As stated above, EPA supports including a minimum window count requirement because it is important that the HDIUT requirements not create a situation where an engine's emissions compliance is judged on the basis of a small sample of data. However, EMA is concerned about the specific proposal for minimum window counts.

As an initial matter, we are concerned that 2,400 windows, as proposed, could be insufficient to make a robust determination of compliance. EMA understands that this figure, which could represent as little as 40 minutes of data (though in most cases it will include more "real-time" data) is based upon the duration of typical test cell certification cycles. However, test cell certification cycles are not a good reference for this purpose, because there is much more randomness to the duty cycles, ambient conditions, engine operating conditions and other factors that can influence emissions during an actual in-use test compared to the strictly controlled cycle and conditions of a certification test in an emissions laboratory. Data convergence to a reasonably representative level has to occur during the test-day. For this reason, we believe that much longer time periods (i.e., much longer than 40 minutes) are necessary for a fair and reasonable assessment in-use. EPA should demonstrate with representative data how many windows are sufficient to reasonably represent a vehicle's emissions performance in any bin during an in-use test.

To analyze the practical consequences of the proposed 2,400 window threshold, we can turn again to real-world data as recorded by WVU on the 100-vehicle fleet in Southern California. Presented in the table below are the percentage of test-days where <2,400 windows were recorded for the day. The table includes the view for the entire fleet, and for two of the worst-case categories for bin window-count.

Vehicle category	Qty vehicles tested	Number of test-days, total	Percentage of test days having <2,400 windows		
			Idle Bin	Low Bin	M/H Bin
Fleet (all vehicles)	100	2077	42%	14%	17%
Food/beverage/distribution, heavy	15	309	90%	47%	70%
Drayage	17	414	0%	20%	34%

It is clear from this data that manufacturers will very frequently encounter test-days that fail to accumulate the proposed requisite number of 2,400 windows in each bin. The data presented here from the 100 vehicle test fleet indicates a higher percentage of vehicles requiring more than one test day than the data EPA presents in Figure 2-24 of the RIA. That data is based on 168 shift days of testing, from which it is estimated that about 8% of test days would fail to meet the 2,400 window minimum in the Idle Bin, about 3% in the Low-load Bin, and less than 2% in the Medium/high load Bin.

WVU's analysis presented in the table above, however, is based on a much more robust and statistically significant 2077 days of testing, and therefore provides a more reliable projection of the probability of the need for additional test days. WVU's analysis also includes assessments of particular vehicle types. To the extent that EPA may select an engine family that is dedicated to light load applications, such as food and beverage or drayage, we can plainly see the very high probability of multiple test-day requirements. Based on more than 400 test-days' experience, drayage applications would require a second day of testing about 34% of the time. Food and beverage distribution would require a second day of testing roughly 70% of the time, based on more than 300 days' worth of testing. That in-use testing burden is not practical or sustainable.

Examination of the likelihood of the idle bin not accumulating 2,400 windows in a test day is especially concerning. EMA therefore supports EPA's proposal to permit the manufacturer to intercede "anytime during the shift day to increase the number of windows in the idle-bin." Due to the "hands-off" nature of the in-use test program, the only real option for manufacturers to make any kind of effort to idle the vehicle for the sake of accumulating windows is at the end of the shift day. EMA nonetheless considers this a reasonable approach and supports the manufacturers' opportunity to fulfill idle bin requirements in that way.

Unfortunately, if a vehicle is equipped with an automated 5-minute shutdown timer, as required under various state and local regulations, it will not idle for the required time of the proposed amendment without shutting down. The same would be true if the fleet from which vehicle is being tested has programmed the vehicle for automated shutdown after a period of time. The Agency should allow the manufacturer to override the automated shutdown feature where possible, or to "blip" the throttle periodically as needed to reset the automated shutdown timer.

There is also a special case to consider where a manufacturer utilizes stop-start technology to reduce criteria emissions and GHG emissions. Engine shutdown would likely occur almost immediately upon entering an idle condition. Depending on how the manufacturer has implemented the technology, there may be no opportunity to override the stop-start function. That feature, implemented for emissions reductions reasons, could make it impossible to accumulate idle bin windows in almost all vehicles where it is deployed, regardless of application. EMA therefore recommends that EPA establish a policy that stop-start engines will not be held accountable to Bin 1 standards.

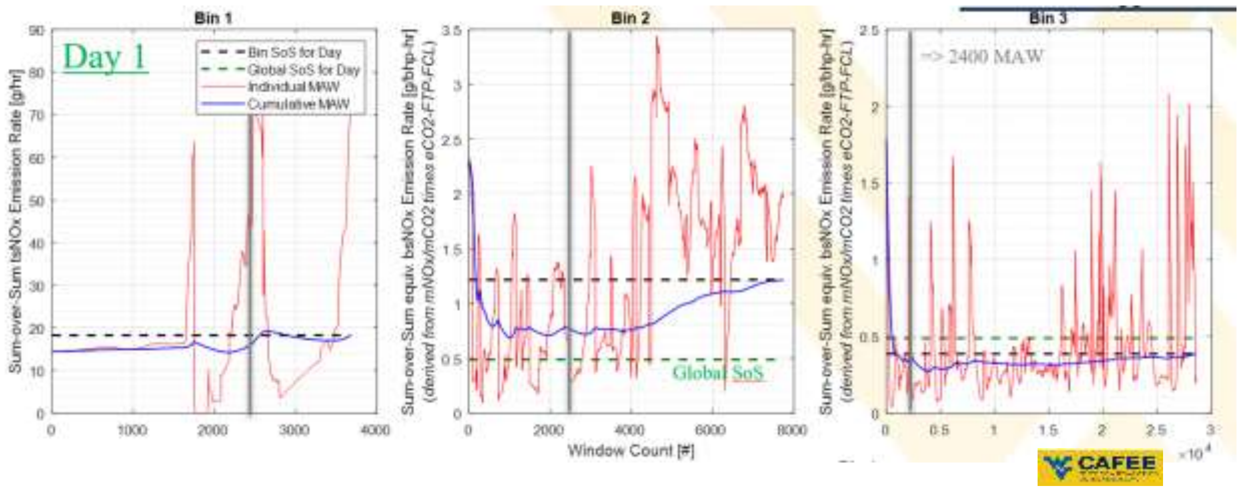
While the option to accumulate additional windows in the idle bin by idling the engine for a period of time is a workable solution to meet the idle bin minimum window count requirements for most vehicles, there are no convenient options to address the minimum window count requirements of Bins 2 and 3 – requirements that will, according to WVU's analysis, all too frequently require additional test-days. EMA recognizes that there is a tension between having *enough* data to make a responsible judgment about bin compliance on a test article, while also needing to *limit* the data requirements to avoid an excessive number of test-days to fulfill the minimum data needs. In the next section, EMA will present additional WVU analyses that demonstrate the need for window count requirements much greater than 2,400 windows to ensure that an accurate and robust assessment is made based on data that has reasonably converged on the average emissions performance of the test article in each bin. The greatly increased number of additional test-days that would be required to accumulate that elevated minimum window count requirement will also be assessed. Additionally, EMA will propose a modification to the 3B-MAW process that is responsive to EPA's request for comments regarding the possibility of combining 3B-MAW bins, and that should largely overcome both the data convergence issue and the multiple test-days issue that undermine the feasibility of the current 3B-MAW proposal.

g. Sufficient data must be accumulated to make a fair and accurate assessment of a test vehicle's in-use emissions performance

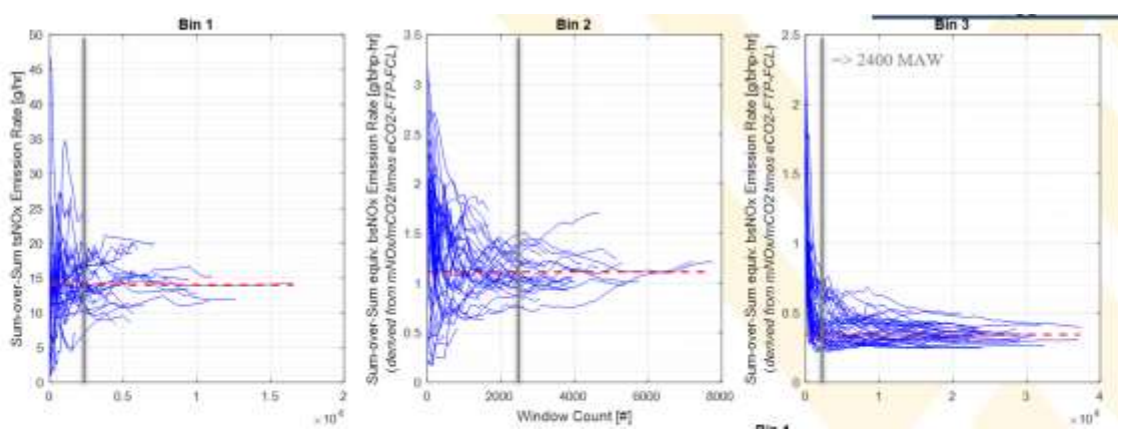
As discussed above, EPA has proposed a minimum window-count requirement for each bin to ensure that sufficient data has been acquired on a test vehicle to accurately judge its emissions control performance in-use. EMA recognizes the importance of that goal, as it is the only fair way to conduct an in-use compliance assessment. We have expressed concern earlier in these comments, however, that EPA's proposal for establishing a minimum window count of 2,400 lacks a sufficient technical basis. While not discussed in the preamble or the RIA, it is understood from earlier discussions with EPA staff that 2,400 windows was selected as a minimum window count requirement for each bin because the equivalent duration of time represented by 2,400 windows, 40 minutes (actually 45 minutes considering the 5-minute window length), is the time required to complete the RMC steady-state emissions dyno test.

EMA requested that WVU conduct a deeper investigation of data convergence tendencies during in-use testing under 3B-MAW requirements using the 1Hz data recorded from the more than 2200 days of testing of the 100-vehicle Southern California fleet. The results of that analysis are presented in the graphics that follow (the complete summary analysis is included in **Exhibit "H"**).

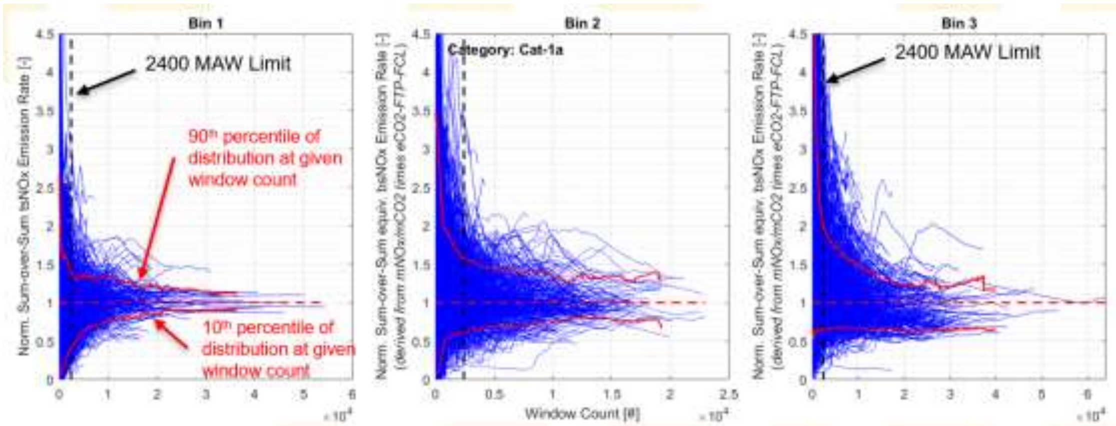
By way of explanation, consider the graphs below, which report bin emissions results over one day of emissions testing of a line-haul vehicle. Each graph tracks the bin's sum-over-sum emissions results as they develop, window by window, from the very first window to the very last window acquired in the test day. For each bin, the red line is reporting *individual* window results as they come in (and is thereby highly variable). The blue line is reporting the bin's *cumulative* emissions results from all accumulated windows up to any window count point (on the horizontal axis). For example, the first window in Bin 1 had a NO_x level of about 14 g/hr. At the time the 2000th window was captured, that 2000th window had a NO_x level of approximately 2 g/hr, whereas the cumulative Bin 1 results by that time (representing essentially the average emissions from all 2000 windows per the 3B-MAW process) calculates to just over 14 g/hr. By the end of the test day, some 3,600 to 3,700 windows had accumulated in Bin 1, with the day's Bin 1 results at approximately 19 g/hr. It is interesting to observe how the more extreme instantaneous results "pull" the average up or down. The Bin 2 and Bin 3 results are presented in a similar manner, but using the appropriate metric of g/bhp-hr as required by the 3B-MAW process. By this analysis technique, one can see how individual window results vary widely depending on operating speeds and loads and other varying conditions throughout the day, but, with the accumulation of sufficient windows, the data "settles in" to the reported average day's emissions.



If we focus on the "blue line" cumulative bin results, and graph multiple days from a single test vehicle in the same plot (again, for each bin), we can see below how the data convergence trends develop with each test day. The horizontal dashed line represents the average NO_x emissions from all of the test days combined.



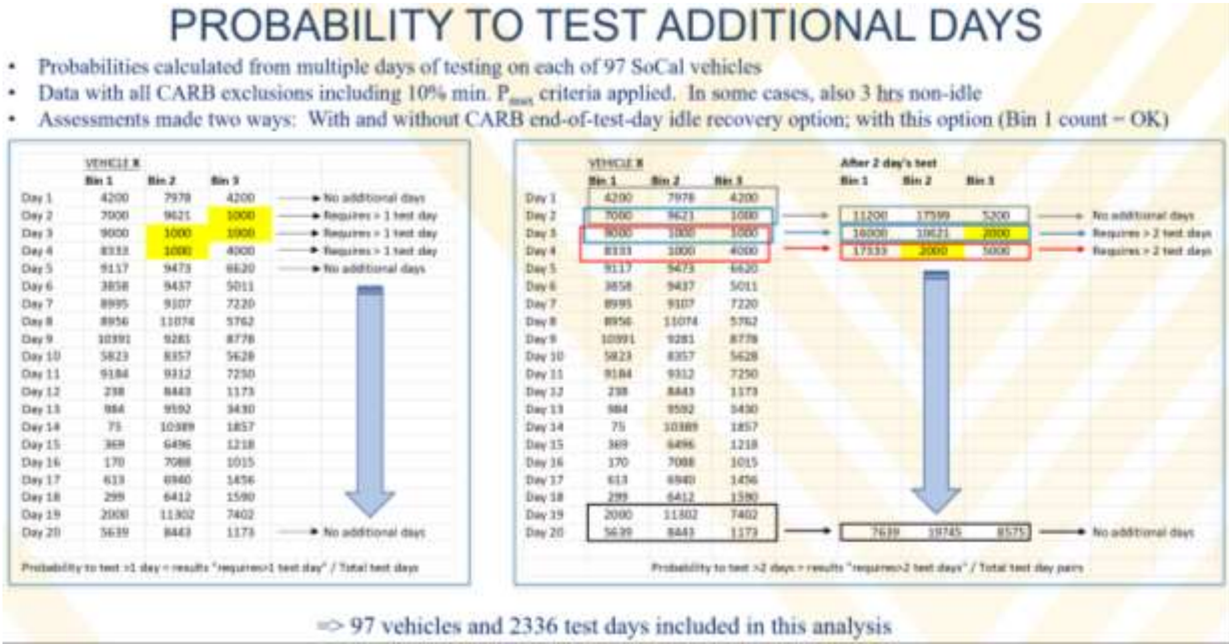
To support the data-convergence assessment desired from this analysis, it is helpful to normalize individual-day data traces relative to the average emissions results from all test days. This allows us to see the convergence trends more clearly, reducing the effects that the day-to-day variation of bin emissions results can have on clouding the picture of when sufficient convergence is achieved. This is especially helpful when reporting the results from multiple test days with multiple vehicles, and so helps to avoid the disproportionate impacts from the unique emissions characteristics of individual trucks. The results from the normalized data highlight the convergence we are trying to identify, as depicted below:



Also shown in this set of graphs above are the 90th and 10th percentile results (the red lines) from the multiple vehicle, multiple test-day results for these line-haul vehicles. As should be expected, these 90th and 10th percentile levels are very high or very low (respectively) during the earliest portions of each test day, until the windows accumulate, and the data begins converging toward each vehicle's representative emissions.

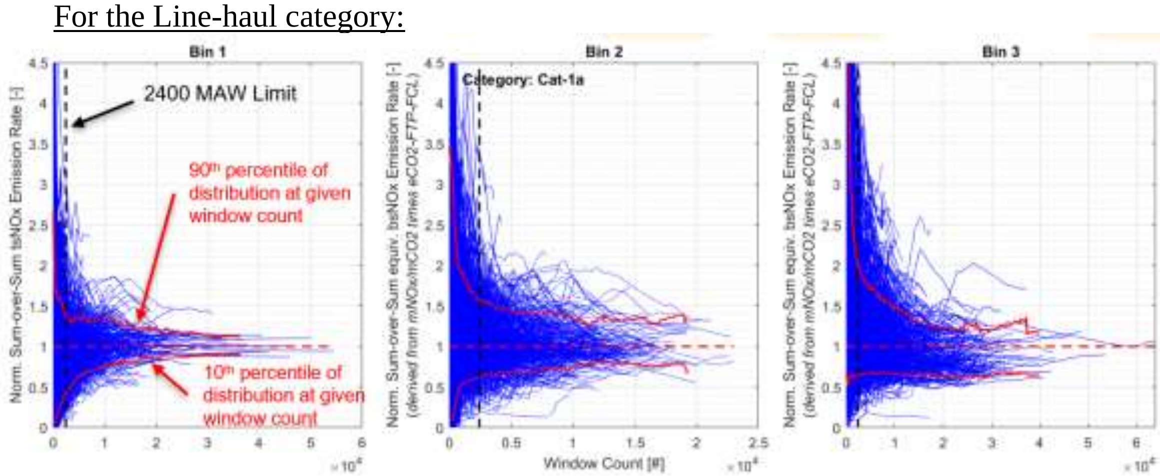
The most important thing to observe in these graphs is that by the 2,400th accumulated window in each bin, the data (it is best to consider the 90th and 10th percentile trends) appears to have not yet adequately converged to a "settled" level of emissions. This is especially evident in Bin 3, where sufficient convergence does not occur until perhaps 15,000 windows.

These analyses point to the need for significantly more than 2,400 windows in a test day to accurately and fairly assess a vehicle's "nominal" emissions results in each of the proposed 3B-MAW bins. The complication that finding presents, however, is a potential need for multiple test-days to accumulate the requisite number of windows. For this reason, WVU pulled the test-days' correlation into this data convergence analysis. The process for estimating test-day requirements for various assumed window count requirements was again based on analysis of the 20 to 30 test-days conducted on each of the 100 vehicles tested in Southern California. By capturing the number of windows accumulated in each bin from each test day, WVU strung together multiple combinations of test days to generate essentially random effects of combined test day window counts. The technique is explained here:



Probabilities to test multiple days were developed for each vehicle category (line-haul, short-haul, drayage, and so on). Some of the vehicle categories' results are presented in the following pages, along with tables that report the probability of having to test one, two, three or even more days depending upon various minimum window count assumptions. The tables also report the benefits of including the end-of-day idle option to accumulate windows in Bin 1 if necessary (the assumption is that Bin 1 will never compel a second test day on its own). To illustrate, by way of example, a line haul vehicle will have an 81.5% chance of requiring more than 1 day of testing if a minimum window count of 10,000 windows per bin were applied, a 36.3% chance of requiring more than 2 days of testing, and a 15.8% chance of requiring more than 3 test-days, even while utilizing the end-of-day idle test option.

For the Line-haul category:



Without Idle Test Option

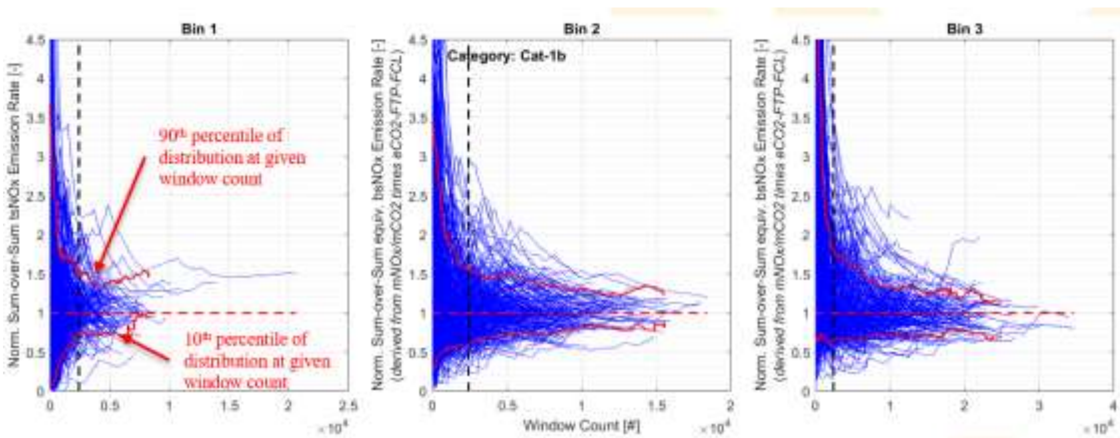
Individual Bin 1, 2, 3 (Default Method)								
w/o idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	30.0	57.2	74.4	89.0	96.9	98.5	100.0	100.0
Chance to test > 2 day [%]	6.7	24.3	44.2	57.2	63.2	71.3	80.0	89.3
Chance to test > 3 day [%]	1.1	9.3	22.2	36.8	49.3	55.0	59.7	64.4
Chance to test > 4 day [%]	0.1	3.3	9.6	21.7	33.5	43.9	50.0	54.7

With Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/ idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	14.4	41.1	63.9	81.5	94.2	97.6	99.6	100.0
Chance to test > 2 day [%]	2.6	9.3	22.4	36.3	50.0	61.9	71.5	81.1
Chance to test > 3 day [%]	0.4	2.9	7.1	15.8	24.3	34.7	44.4	52.4
Chance to test > 4 day [%]	0.0	1.0	3.2	6.8	11.9	19.3	26.1	34.7

For the Short-haul category:

In this case, WVU is also showing the benefits of using vehicles in applications where the engine's activity included a minimum of 3 hours of non-idle operation.



Without Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/o idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	62.8	85.7	96.3	99.4	100.0	100.0	100.0	100.0
Chance to test > 2 day [%]	34.4	61.9	77.9	86.6	93.9	97.2	98.9	99.6
Chance to test > 3 day [%]	21.2	45.5	60.8	73.6	82.0	88.1	92.9	95.7
Chance to test > 4 day [%]	16.5	32.5	47.4	61.5	71.6	78.6	84.8	88.3

With Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/ idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	26.8	51.5	68.8	85.1	94.2	98.5	99.8	100.0
Chance to test > 2 day [%]	12.1	22.5	33.8	45.2	57.8	70.8	78.6	87.0
Chance to test > 3 day [%]	8.0	13.4	20.1	28.4	37.2	44.2	51.7	60.2
Chance to test > 4 day [%]	5.8	11.0	14.3	18.8	24.2	30.5	37.7	42.9

Considering only test days with min 3 hrs non-idle

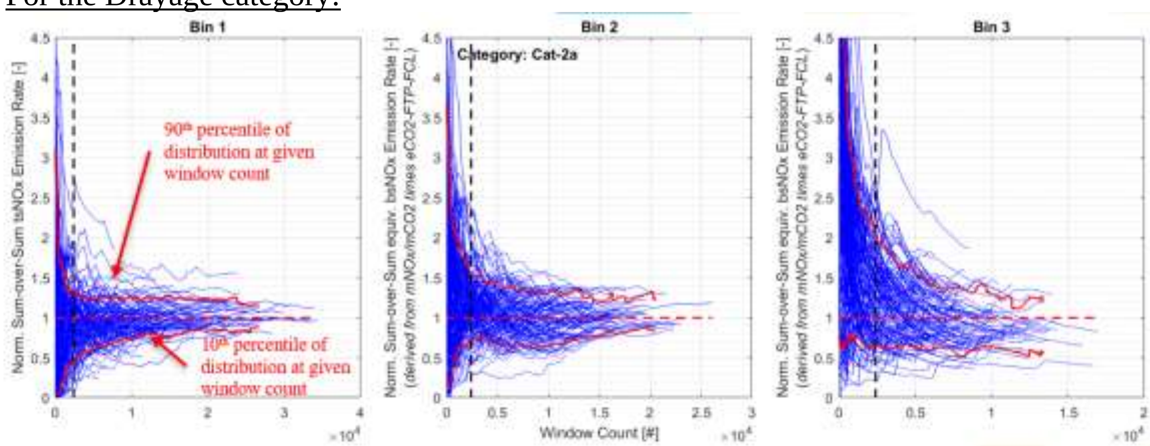
Without Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/o idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	47.1	79.6	94.7	99.1	100.0	100.0	100.0	100.0
Chance to test > 2 day [%]	13.3	43.7	67.2	79.9	91.0	96.3	98.8	99.7
Chance to test > 3 day [%]	3.7	24.1	40.9	61.9	71.5	81.7	89.2	93.5
Chance to test > 4 day [%]	0.9	12.1	26.0	41.2	57.0	67.5	75.9	81.7

With Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/ idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	2.5	30.7	55.4	78.6	91.6	97.8	99.7	100.0
Chance to test > 2 day [%]	0.0	0.3	7.7	22.6	38.1	56.0	66.6	79.6
Chance to test > 3 day [%]	0.0	0.0	0.3	3.7	9.6	18.6	28.5	39.9
Chance to test > 4 day [%]	0.0	0.0	0.0	0.0	1.9	5.0	10.2	17.6

For the Drayage category:



Without Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/o idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	14.8	34.6	61.1	80.2	91.4	99.4	100.0	100.0
Chance to test > 2 day [%]	3.1	8.6	13.6	29.0	42.6	58.6	74.7	84.0
Chance to test > 3 day [%]	1.9	3.7	6.2	9.3	16.0	20.4	30.9	43.8
Chance to test > 4 day [%]	0.6	1.9	3.1	6.2	7.4	9.9	11.1	17.9

With Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/ idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	14.8	33.3	58.6	79.0	90.7	99.4	100.0	100.0
Chance to test > 2 day [%]	3.1	8.6	13.6	25.9	40.1	57.4	73.5	83.3
Chance to test > 3 day [%]	1.2	3.7	6.2	9.3	14.2	20.4	29.6	42.6
Chance to test > 4 day [%]	0.6	1.9	3.1	6.2	6.8	9.9	11.1	17.3

Considering only test days with min 3 hrs non-idle

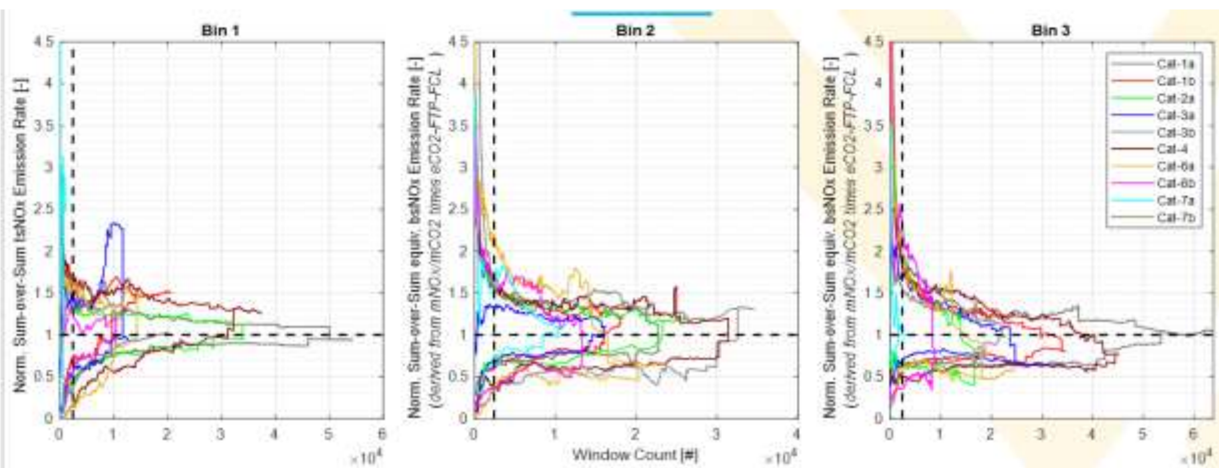
Without Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/o idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	1.5	22.6	54.0	76.6	89.8	99.3	100.0	100.0
Chance to test > 2 day [%]	0.0	1.5	2.2	11.7	26.3	45.3	65.0	78.1
Chance to test > 3 day [%]	0.0	0.0	0.0	0.7	2.2	5.1	13.9	28.5
Chance to test > 4 day [%]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6

With Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/ idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	1.5	21.2	51.1	75.2	89.1	99.3	100.0	100.0
Chance to test > 2 day [%]	0.0	1.5	2.2	10.9	24.8	43.1	63.5	77.4
Chance to test > 3 day [%]	0.0	0.0	0.0	0.7	2.2	5.1	13.1	27.7
Chance to test > 4 day [%]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6

For the entire fleet (all categories combined):
In this case, only the 90th and 10th percentiles are plotted by category for clarity (see the table near the introduction of this section to understand the category references in the legend).



Without Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/o idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	46.1	66.7	80.7	90.2	95.1	97.5	99.0	99.7
Chance to test > 2 day [%]	28.1	42.6	54.8	65.4	73.5	80.2	85.9	90.6
Chance to test > 3 day [%]	22.0	32.2	41.0	49.7	57.8	63.9	69.8	74.8
Chance to test > 4 day [%]	19.8	26.3	32.7	40.8	47.8	53.5	58.5	63.4

With Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/ idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	22.6	44.9	64.5	78.5	88.6	93.9	96.4	98.0
Chance to test > 2 day [%]	9.4	18.3	28.5	40.2	52.4	63.7	71.1	78.9
Chance to test > 3 day [%]	5.3	11.6	16.7	22.8	30.2	38.2	46.7	54.6
Chance to test > 4 day [%]	3.5	7.8	12.6	16.1	19.9	25.0	30.8	37.3

Considering only test days with min 3 hrs non-idle

Without Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/o idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	31.7	56.8	74.8	87.2	93.6	96.7	98.7	99.7
Chance to test > 2 day [%]	15.1	28.9	42.3	54.8	64.2	72.7	80.5	87.1
Chance to test > 3 day [%]	11.1	18.5	27.1	37.3	45.5	52.7	59.3	65.9
Chance to test > 4 day [%]	10.0	13.6	18.9	26.7	34.5	40.6	46.5	52.2

With Idle Test Option

Individual Bin 1, 2, 3 (Default Method)								
w/ idle test option	Window Threshold							
Probability Distribution	n = 2,400	n = 5,000	n = 7,500	n = 10,000	n = 12,500	n = 15,000	n = 17,500	n = 20,000
Chance to test > 1 day [%]	6.4	29.7	54.0	71.9	85.1	92.1	95.3	97.4
Chance to test > 2 day [%]	1.2	4.3	12.0	24.1	37.8	51.3	61.0	71.0
Chance to test > 3 day [%]	0.2	1.5	3.2	7.3	13.1	21.9	30.7	40.5
Chance to test > 4 day [%]	0.0	0.8	1.9	2.7	5.2	8.5	14.4	21.3

In each of the vehicle-category examples presented above, it is clear that the 2,400 minimum window count requirement that EPA has proposed is not adequate to ensure a fair and accurate assessment of a vehicles' emissions performance. It is also clear from the test-day requirement tables that increasing the minimum window-count requirements to more appropriate levels, perhaps 10,000 to 15,000 windows, to ensure a reasonable probability of data convergence, will very frequently lead to two, three, and occasionally even four days of testing as a matter of regular practice. Obviously, that is an untenable situation, as it will present undue burden for manufacturers, and undermine customers' willingness to support the HDIUT program.

There is a question regarding the relevance of the results and conclusions of the foregoing analysis because it is based on test results from engines compliant to US10 emissions standards, rather than engines designed and calibrated to the protocols and the range of emissions standards that EPA is proposing in this rulemaking. In response, EMA first points out that the analyses that relate number of required test-days to minimum window count provisions are completely independent of the emissions levels in question. The consequences are strictly related to operational activity, which is not expected to be altered by the proposed regulations.

Regarding the data convergence tendencies, it is correct that the data that served as the basis for these analyses were recorded on US10 vehicles. However, the relevant data variability will increase, not decrease, relative to the proposed low-NO_x emissions standards. That additional variability can be attributed to several of the issues raised in these comments, including (1) the inability to control tailpipe emissions with greater precision than today, without any significant improvements in sensor accuracy or actuator precision, (2) the inaccuracies of PEMS equipment relative to the anticipated standards, (3) other sources of production variability expected to lead to similar absolute levels of tailpipe uncertainty, yet with lower absolute tailpipe emissions levels, and (4) the impacts of system degradation, including SCR efficiency loss, on a control system that depends even more heavily on high catalyst conversion efficiencies than today's US10 systems. Accordingly, it is unlikely that data convergence will occur over fewer windows with future technologies.

If EPA staff believes that this is an invalid assessment, they should produce the data necessary to demonstrate that 2,400 windows are adequate to make an accurate and fair assessment of any vehicle's emissions in any bin. Unfortunately, the Agency's testing of "future technology" is limited to test cell demonstrations, with at most 3 protype test articles, primarily run over dyno-based certification cycles, with only a handful of road cycle simulations, also run on an engine dyno. Without creating the robust data to make a better case than EMA has made on these important issues, EPA should use the best available data. The best available data is the 100 vehicle SoCal study conducted by WVU, which is the basis for EMA's analysis.

h. Combining the Low Power Bin and the Medium/high Power Bin can resolve data convergence and minimum window-count concerns

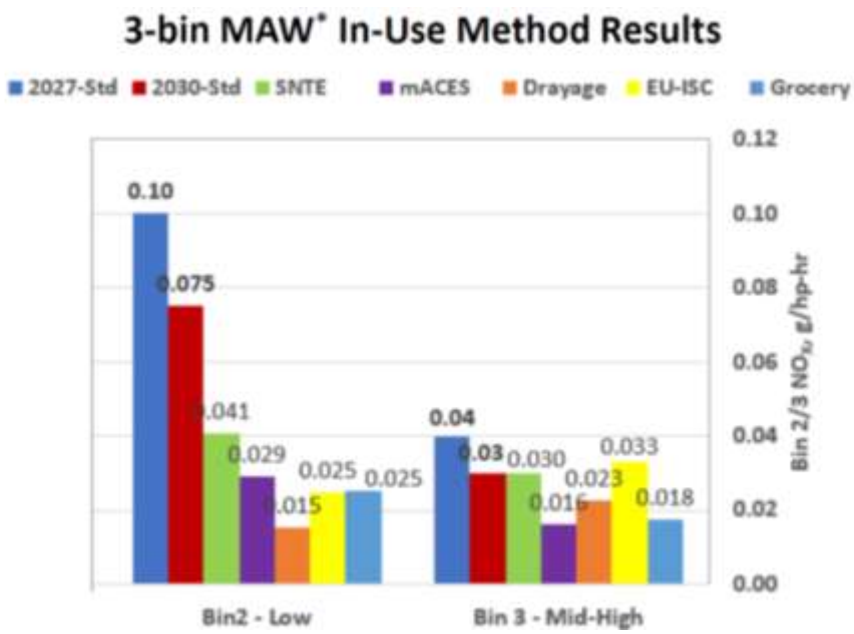
In the preamble to the NPRM, EPA requests comments on ways to improve the 3B-MAW in-use protocol, including, specifically, combining certain of the bins. The bin combination that EPA discusses briefly in the NPRM is combining Bin 1 and Bin 2. EMA does not find that type of combination to be practical or justified. First, the emissions characteristics of Bins 1 and 2 are very different and less consistent, especially when compared to the greater similarities in the Bin 2 and Bin 3 results. More specifically, the SwRI 800,000-mile results show average brake-specific Bin 1 emissions as calculated by the 3B-MAW process (but in g/bhp-hr to enable comparison of results) across the five road cycles tested to be 0.081 g/bhp-hr, whereas the Bin 2 average is 0.042 g/bhp-hr, and the Bin 3 average is 0.030 g/bhp-hr. The spread in those results (delta from lowest to highest) is significantly more consistent between Bins 2 and 3 than Bins 1 and 2 (Bin 1 spread = 0.113 g/bhp-hr. Bin 2 = 0.015, Bin 3 = 0.024). Secondly, there is interest to have an independent evaluation of the idle condition that EPA proposes to control with the optional low-NO_x idle standards. EMA supports that EPA is not proposing a stand-alone vehicle-level idle test such as that CARB proposed in its Omnibus regulations, and instead has proposed to assess idle or near-idle emissions within the 3B-MAW protocol. For these reasons, EMA does not recommend combining Bins 1 and 2.

Instead, EMA and WVU have considered a modification to the proposed 3B-MAW protocol that would overcome the identified data-convergence and multiple test-days issues. One promising modification in that regard is to combine the Low Power (Bin 2) and Medium/High Power (Bin 3) windows into a single bin.

As noted above, EMA finds that the end-of-test idle option is a reasonable approach to meeting the 2,400 minimum window-count requirement in Bin 1. No such convenient method exists, however, to ensure adequate window-count, and thereby adequate data convergence, in Bins 2 or 3 after a day of testing. To remedy that, EMA proposes to combine Bins 2 and 3 into a single bin when determining bin emissions levels. Adding the Bin 2 and Bin 3 windows will greatly improve the chances to avoid multiple test-days when window-count requirements are set to levels that reasonably assess – and converge around – a vehicle's nominal emissions characteristics.

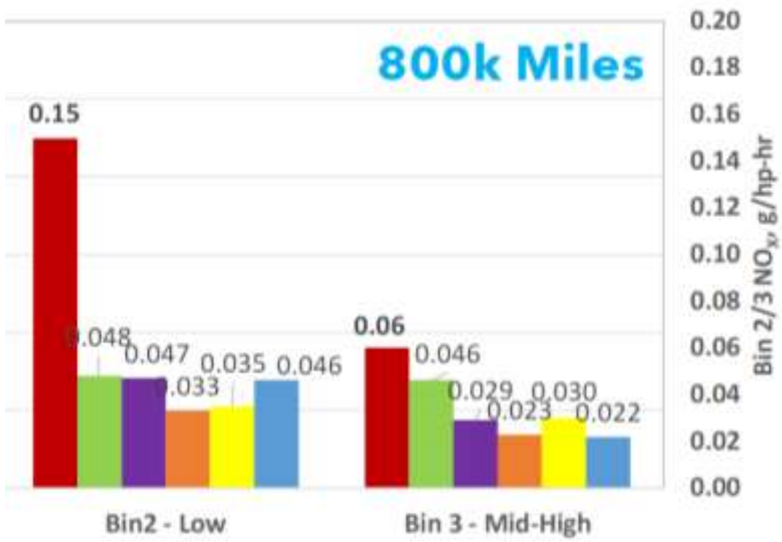
The Bin 2 and Bin 3 definitions with respect to normalized CO_2 cutpoints can be maintained as a means to ensure that vehicle activity is reasonably distributed across the operating spectrums represented by those bins. By combining those two bins before calculating a combined Bin 2+3 emissions level, to be evaluated for compliance against an appropriate combined Bin 2+3 emissions standard, data convergence can be achieved without the onerous need for multiple test-days to achieve reasonable convergence in the combined Bins 2 and 3.

Combining Bins 2 and 3 not only resolves the data convergence and test-day requirements of 3B-MAW as proposed, it is also supported by the Stage 3 RW engine data as reported by SwRI. When this future technology configuration was tested over the five road cycles discussed earlier, the NO_x emissions levels of Bins 2 and 3 were largely the same. The enhanced thermal management routines and LO-SCR improvements to control Bin 2 emissions result in Bin 2 NO_x levels on par with those in Bin 3, as seen from the Stage 3 RW results (at 435,000 miles equivalent) below.[16]



Similar results are observed after 800,000 miles of aging:

[16] As mentioned earlier, these results do not consistently comply with the 2031 NO_x standards EPA has proposed.



As mentioned, the Agency's proposed Bin 2 and Bin 3 definitions could still play an important role to ensure that manufacturers are demonstrating emissions compliance over a broad range of operational modes. For example, EPA could require that among the total windows accumulated in the combined Bin 2+3, at least some minimum percentage of those windows would need to be Bin 2 windows, and a similar minimum percentage would need to be Bin 3 windows. Such a fleet-level operational activity requirement in the in-use test program would ensure that manufacturers' compliance demonstrations include emissions generated from multiple types of operations consistent with EPA's 3B-MAW definitions.

i. EMA's proposal to modify the 3B-MAW in-use test protocol

Consistent with the foregoing discussion, EMA proposes the following adjustments to the 3B-MAW protocol as proposed:

<u>Minimum data requirements:</u>

- Minimum 3 hours of non-idle operation
  - Minimum 3 hours of non-idle operation should also be an acceptable vehicle screening criteria.
  - Minimum engine coolant temperature of 20°C.
- Idle bin (Bin 1) minimum data requirement should be 2,400 windows as proposed.
  - End of test-day idling option should be adopted.
- Bin 2 + Bin 3 minimum window count requirement: 10,000 windows.
  - Test additional days if not met

<u>Emissions calculations:</u>

- Bin 1: As proposed by EPA
- Bin 2 + Bin 3: Calculate emissions from all combined Bin 2 and Bin 3 windows as if a single bin.

In the proposal outlined above, the 3 hour non-idle operation requirement is consistent with acquiring adequate data to make a fair and accurate assessment of a vehicle's compliance. With the recommended requirements on fleet-level minimum Bin 2 and Bin 3 activity, manufacturers can modify their vehicle recruitment path as they progress in the test program to meet these targets (with EPA approval as necessary).

Regarding the minimum Bin 2+3 window-count requirement for any test-day, EMA is proposing 10,000 windows. We believe this is the appropriate window-count requirement that balances data-convergence concerns and risks to test multiple days. There is considerable uncertainty with respect to the in-use emissions performance that should be anticipated from the types of emissions control packages that EPA has investigated as the basis for this rulemaking. Considering the infinite number of road cycles that will be encountered in-use, the barely-evaluated impacts of NO_x breakthroughs (especially those involving cold-start emissions, or resulting from return-to-service events that can be numerous under some untested duty cycles), the range of ambient conditions, the known SCR-degrading impacts of "any commercially available" fuels, the untested durability of cylinder deactivation technology, and all of the other factors that EMA has outlined regarding compliance margin requirements, the need to ensure robust data convergence in this matter is paramount.

In setting the standard for the combined Bin 2+3, EPA must take all of this uncertainty into account, as well as the simple fact that EPA has so far demonstrated that the Stage 3RW package is *incapable* of meeting the proposed standards, both dyno certificaton standards and in-use standards, despite its having been operated solely in the carefully-controlled laboratory setting. In that regard, EPA cannot simply establish emissions standards on the basis of "wishful thinking." Accordingly, EMA proposes that the Bin 2+3 emissions standard be set at the average of Option 2-like LLC and FTP/RMC standards, adjusted upward by the appropriate in-use conformity factor, which should be 2.0 for at least seven model years before dropping down to 1.5.

As mentioned earlier in these comments, EPA and engine manufacturers need time to become familiar with the completely overhauled in-use test protocol and measurement processes, the capabilities and weaknesses of the ultra-low NO_x emissions technology packages of the future, the impacts of a diverse and evolving market fuel-mix over newly-extended useful life requirements, and the numerous other factors that drive the uncertainty all stakeholders are faced with during the course of this rulemaking. Applying a conformity factor of 2.0 for the first 7 years following the effective date of these new standards will provide that prove-out time wihout undue risks of noncompliance. This aspect of EMA's proposal is addressed directly in Section 9 of these comments. Failing to provide adequately for a higher inteirm standard would unjustifiably and unnecessarily put engine manufacturers at risk of managing products in the field that were in a state of perpetual recall, simply because the requisite data was not available to set standards in line with the realistic capability of the available technology.

j. NO_x sensor variability inaccuracies further complicate NO_x-binning regulatory protocols

An additional component of SwRI's work has included a technical assessment of the type of MAW-based approach on which EPA intends to build its 3B-MAW in-use compliance program. SwRI's research and findings indicate that the necessary sensors and electronically-broadcast engine parameters may not be accurate or robust enough to implement EPA's 3B-MAW-based approach as envisioned.

Specifically, SwRI has examined whether state-of-the-art NO_x sensors are sufficiently accurate at low-NO_x levels to support the proposed in-use regulations. As depicted in Figures 72 and 73 below from the SwRI Report, SwRI found that "substantial errors can be seen on the order of 10% to 20%, which errors grow larger at low overall NO_x mass levels," and that "NO_x sensor data at present are not yet at the same level of accuracy as some of the other EMC broadcast measurements, such as exhaust flow." (SwRI Report, ISOR Reference 191, p. 63.)

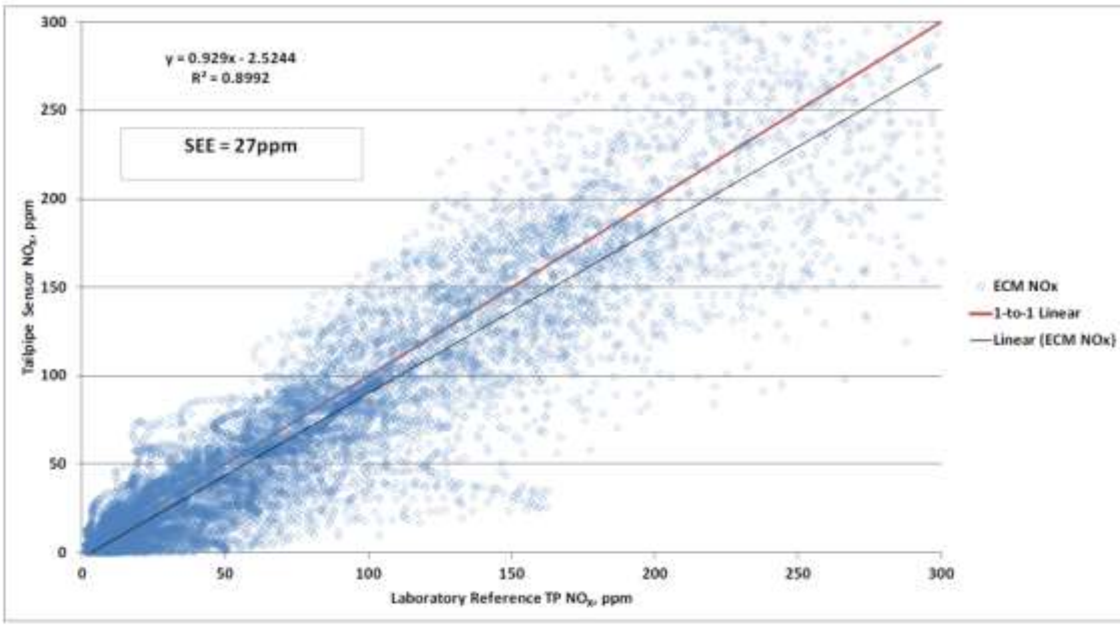


FIGURE 72. EXAMPLE TP NO_X SENSOR VS. LAB REFERENCE TP NO_X CONCENTRATION – LLC AND ARB TRANSIENT CYCLES

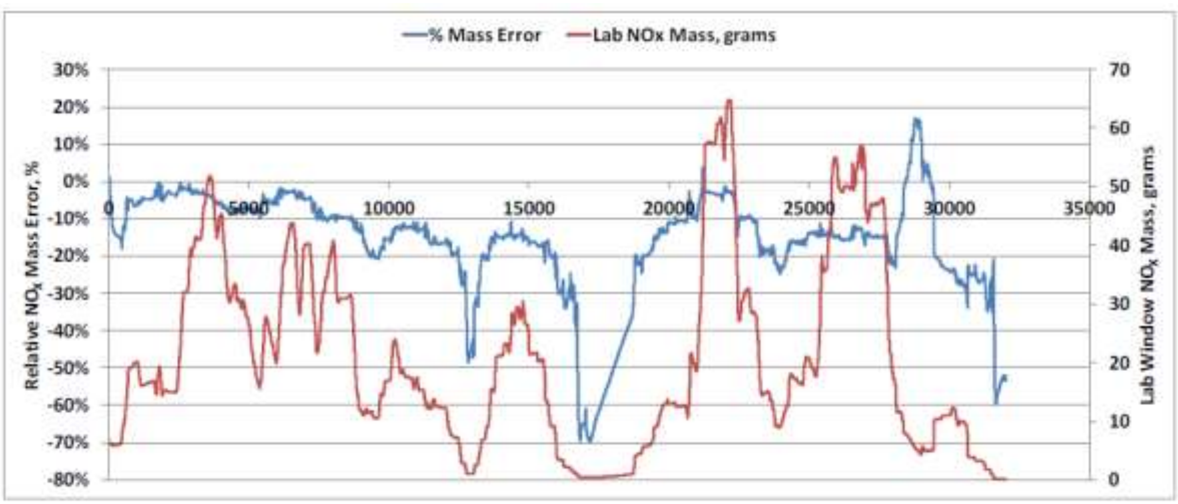


FIGURE 73. NO_X MASS RATE ERROR OVER 20-MINUTE INTEGRATION WINDOWS BASED ON SENSOR VS. LAB CONCENTRATIONS (WITH SAME EXHAUST FLOW)

SwRI also highlighted what WVU's analyses have revealed: the MAW-based method does not yield any clear trends in emissions behavior, and can disproportionally weight brief spikes in NO_x emissions (i.e., NO_x "breakthrough events"). SwRI's specific observations on those issues is discussed below.

First, SwRI observed that the MAW-based approach "indicates no clear trend [in emissions] other than a high frequency of very low numbers, but the rest of the distribution is *scattered somewhat randomly* between 0.05 and 0.35 g/bhp-hr." (SwRI Report, CARB ISOR Reference 191, p.77.) (Emphasis added.) SwRI also noted that the MAW-based approach "provides little information about where emissions are coming from in terms of engine operating modes." (SwRI Report, CARB ISOR Reference 191, p. 79.) SwRI depicted that overall variability in the MAW-based emissions data as follows:

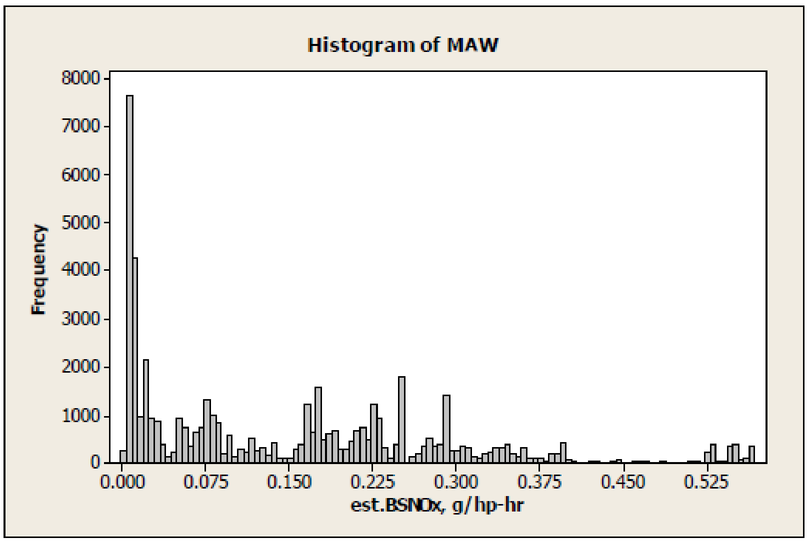


FIGURE 86. HISTOGRAMS OF EST. $BSNO_X$ FROM MAW ANALYSIS

Second, SwRI, like WVU noted, that the MAW-based approach tends to overweight "return to service events after a long low-load period," which "could result in an overemphasis of those relatively brief spikes in a Low NO_x environment," with "a large number of windows being driven by a small number of breakthroughs." (SwRI Report, CARB ISOR Reference 191, pp. 66, 69 and 74.)

In summing up its conclusions regarding CARB's (and now, EPA's) MAW-based approach, SwRI highlighted the facts that NO_x sensors will "require considerable improvement in application and accuracy to support in-use compliance measurements at Low NO_x levels," and that "further investigation of the [in-use] metrics is needed, as well as to set a proper compliance threshold for whichever new metric is chosen." (SwRI Report, ISOR Reference 191, p.88.) Accordingly, SwRI ended its report with the following recommendation: "More analysis needs to be performed before setting a final in-use measurement protocol, and the appropriate compliance thresholds [plural] for that protocol." (SwRI Report, ISOR Reference 191, p. 89.)

Following on that recommendation, and with funding from EMA and other stakeholders, SwRI has conducted additional research on the capabilities of current NO_x-sensors to assess emissions at the ultra-low NO_x values at issue. The results of that follow-on research are significant.

k. PEMS accuracy issues could impact the enforcement of the proposed 3B-MAW standards

Perhaps just as significant as the concerns related to the 3B-MAW protocol, which concerns support the adoption of EMA's alternative combined-bin approach, there are a number of of concerns regarding whether the portable emissions measurement systems (PEMS) that will be used to implement and enforce the proposed in-use testing program are capable of measuring and "binning" NO_x emissions at the near-zero levels that the low-NO_x regulations would require.

Current PEMS may not be capable of measuring and sorting NO_x emissions at levels below the Option 1 Bin 3 NO_x standard of 0.030 g/bhp-hr level. To the contrary, the regulatory-capable NO_x-detection and measurement range of current PEMS is at a level that can be equivalent to a significant percentage of the in-use NO_x limits that EMA's regulations envision, and that is before any in-use operational and environmental conditions and impacts are taken into account.

All stakeholders have recognized the critical importance of evaluating and quantifying the incremental low-NO_x accuracy and variability of current PEMS. Accordingly, multiple stakeholders, including EPA, are collaborating on a PEMS Measurement Allowance (PEMS-MA) Evaluation Project at SwRI. Work under that program is still on-going, and an additional follow-on PEMS-MA in-use validation program will be initiated soon. EPA will need to account for those measurement allowance results before finalizing this rule.

The need for a sufficient PEMS-related measurement allowance is well-established. The current PEMS measurement-accuracy adjustment factor was determined in 2008 through an extensive series of tightly controlled laboratory and in-vehicle tests designed specifically for the assessment of PEMS measurement accuracy and variability. EPA was an active participant in the development of that testing program, which was performed at SwRI.[17]

To put this issue into perspective, today's NTE-based in-use NO_x standard of 0.30 g/bhp-hr (0.45 when the authorized NO_x measurement allowance of 0.15 g/bhp-hr is added on) involves measuring NO_x concentrations on the order of 45 ppm. In comparison, the proposed medium/high load 3B-MAW "Bin 3" in-use Option 1 NO_x standard of 0.030 g/bhp-hr would require measuring NO_x concentrations of approximately 4 to 5 ppm, or closer to 3 ppm since manufacturers would need to design for some minimum level of compliance margin. Those single-digit ppm levels are not far removed from the "drift" of PEMS NO_x measurements over an 8-hour period, before factoring in any of the actual in-use sources of PEMS' measurement inaccuracy and variability, such as signal noise, span errors, time-alignment, fuel and exhaust-flow estimates, interference from other emissions species in the exhaust stream, and varying environmental and ambient conditions. To be able to tolerate unavoidable NO_x breakthroughs in the medium/high bin, the

[17] See "Determination of PEMS Measurement Allowances for Gaseous Emissions Regulated Under the Heavy-Duty Engine In-Use Testing Program." SAE Paper, 2009-01-0938/0939/0940, SAE International Journal of Fuels and Lubricants (2009); EPA Report No. EPA 420-R-08-005 (Feb. 2008); EPA, Direct Final Rule, "In-Use Testing for Heavy-Duty Diesel Engines and Vehicles; Emission Measurement Accuracy Margins for Portable Emission Measurement Systems," (73 FR 13441-52, March 13, 2008).

overall window result would basically have to be zero. Thus, 2 or 3 ppm of PEMS measurement error, on its own, could lead to a non-compliant in-use NO_x result.

Significantly, the measurement "drift" that is permitted under the relevant federal and CARB specifications for emissions-measurement equipment (see 40 CFR 1065.550) would equate to a 0.0008 g/bhp-hr drift limit at the low NO_x levels that EPA is targeting, a drift limit that would be difficult even for laboratory grade instruments to meet, let alone PEMS.

Given the foregoing, it is vitally important for EPA to fully account for the results of SwRI's current PEMS-assessment program before finalizing the in-use compliance elements of EPA's low-NO_x regulations. EPA's proposal to provide for a 10% accuracy margin (see NPRM, p. 219) is simply not adequate nor sufficiently data-based. It would amount to a 0.003 g/bhp-hr NO_x margin for Bin 3, as compared against the current NO_x accuracy margin of 0.15 g/bhp-hr. EPA has not and cannot demonstrate that such a 98% reduction in the in-use accuracy margin for NO_x is appropriate.

Regarding spark-ignited engines, EMA does not support the addition of the in-use MAW requirements for gasoline SI engines. EPA's addition of the SET test for gasoline engines sufficiently covers real-world operation, especially with respect to high-load operation where gasoline engines are most challenged for tailpipe criteria emissions. Additionally, low-load operations should not be a concern, since gasoline SI engine inherently have much higher exhaust temperatures than diesel.

7. EPA's Additional Changes with Respect to In-Use Testing Practices are Unworkable

EPA has proposed other procedural changes to the HDIUT program that are just as significant and problematic as the proposed numerical in-use standards. Those procedural changes will need to be revised in order to allow for an implementable in-use testing program.

a. EPA should not convert the HDIUT program into a strict liability program

As noted above, EPA is proposing to eliminate "Phase 2" in-use testing, and to convert the "Phase 1" testing into what amounts to a strict liability program. Given the multiple uncertainties associated with the new proposed in-use testing protocols, that is not reasonable.

Under the proposed re-write of the HDIUT program, "failures" of the current "Phase 1" HDIUT procedures (where 5 out of 5, 5 out of 6, or 8 out of 10 vehicles need to "pass" the in-use compliance metrics) would be sufficient on their own to support a finding of "noncomformity" or "noncompliance," and thus, presumably, sufficient for EPA to compel an HDOH engine family recall.

EPA's proposed amendment of the HDIUT program would impose unreasonable risks of recall liability on manufacturers. The HDIUT program (codified at 40 CFR Part 86, Subpart T, §§86.1901-86.1935) is a program that resulted from a negotiated settlement of litigation that EMA filed in 2001 challenging EPA's authority to require that manufacturers test previously-sold non-new vehicles no longer in the manufacturers' possession and control. (See 70 FR at 34597.) As a result of a duly approved settlement agreement between CARB, EPA, EMA and manufacturers (which settlement was subject to a thorough public notice and comment process), the parties developed and specified the terms of the HDIUT program. (Id., n.2.)

As negotiated and agreed, the current NTE-based HDIUT program does not compel recall or other noncompliance liability solely on the basis of an engine family failing to meet the engine family "pass" critieria (where 5 out of 5, 5 out of 6, or 8 out of 10 in-use vehicles pass) as tested under "Phase 1" of the program. Instead, under the current negotiated regulations, EPA enters into further discussions with the manufacturers regarding the extent of any appropriate follow-up steps, which steps can include no further testing, additional targeted "Phase 2" testing, engineering studies, or, if deemed necessary, targeted remedial actions. The core concept is that any initial "failure" of Phase 1 testing is simply a trigger for further discussions and assessments, not a trigger for strict noncompliance liability. (See 70 FR at pp. 34595-96, 34598 and 34601.)

In light of the foregoing, EPA's proposed establishment of a de facto strict-liability HDIUT program — with automatic recall liability for any "failed" Phase 1 testing — is contrary to the foundational agreements and terms that created the HDIUT program. EPA should not alter the current HDIUT testing and flexible enforcement scheme.

b. EPA has not provided for the possibility of HHDE-equipped vehicles being tested within a family, but held to different in-use standards.

EPA proposes to establish two-stage NO_x emissions standards for HHDE engines, where the second, higher standard is applicable to the later portion of useful life. These two-stage standards would apply to in-use emissions requirements as well. EPA's engine family pass/fail criteria under proposed §1036.425 involves, under certain conditions, averaging bin emissions from multiple vehicles. Those provisions, however, do not contemplate the possibility that some vehicles included in the test group may have mileages associated with the first-stage NO_x standard, while others may have accrued mileages triggering the second-stage. As the two stages have distinct standards, it would not be appropriate to average their emissions as though they were compliant to a single unform standard.

EMA recommends that the provisions of §1036.425 be finalized to state that late-stage vehicles should have their emissions results reduced by multiplying them by the ratio of the first-stage standards to the second-stage standards before being averaged with the vehicles in the first-stage. This adjustment should be made after the applicable PEMS measurement accuracy allowance (proposed §1036.420) is added to the measured and calculated bin results.

c. OBD detection capability should not undermine a fundamental principle of the HDIUT Program

EPA has proposed to modify the engine family pass/fail criteria that apply when a manufacturer has conducted an emissions compliance evaluation in response to an EPA in-use test order according to §1036.425. In addition to eliminating the option for "Phase 2" testing, EPA also is proposing to establish more strict requirements regarding the number of engines that must be demonstrated as meeting the emissions standards in order for the in-use test order to be satisfied. Because of the increased risk associated with the relationship between these new and more stringent in-use standards and current OBD detection capabilities, EMA recommends that the pass criteria be relaxed instead.

The family pass/fail criteria currently in place according to §86.1915 provide that a manufacturer should first test 5 vehicles equipped with engines from the engine family specified in the test order. If all 5 vehicles meet the minimum NTE pass-ratio, the manufacturer has satisfied the in-use test order, and may stop testing. If 1 or more of the 5 vehicles do not pass, however, a sixth vehicle must be tested. If after testing the sixth vehicle, 2 vehicles' results do not meet the minimum NTE pass-ratio, the manufacturer must test 4 more vehicles, for a total of 10 vehicles. If 8 out of the 10 vehicles have met the minimum pass-ratio, the test order has been satisfied, and the manufacturer may stop testing. If, however, at least 3 vehicles failed to meet the pass-ratio requirement, the manufacturer is obligated to enter into discussions with the agency concerning additional analysis, and potentially more testing.

To summarize the current family pass/fail criteria, a manufacturer can meet the requirements of the in-use test order if 5/5 ("5 out of 5"), 5/6, or 8/10 vehicles meet the NTE minimum pass-ratio. However, as noted, EPA's proposed amendments would impose stricter criteria for a determination that the test order has been satisfied. More specifically, while EPA has carried over the first two passing thresholds of 5/5 and 5/6, the passing threshold of 8/10 has been eliminated. EPA instead proposes that if a total of 10 vehicles are tested, the average emissions from all vehicles must be below the in-use standard for all bins and all constituents to meet the requirements of the in-use test order. EPA has thereby proposed to eliminate the condition that if 8/10 vehicles pass the in-use emissions requirements, the manufacturer's obligations under the test order have been satisfied, and no further testing required.

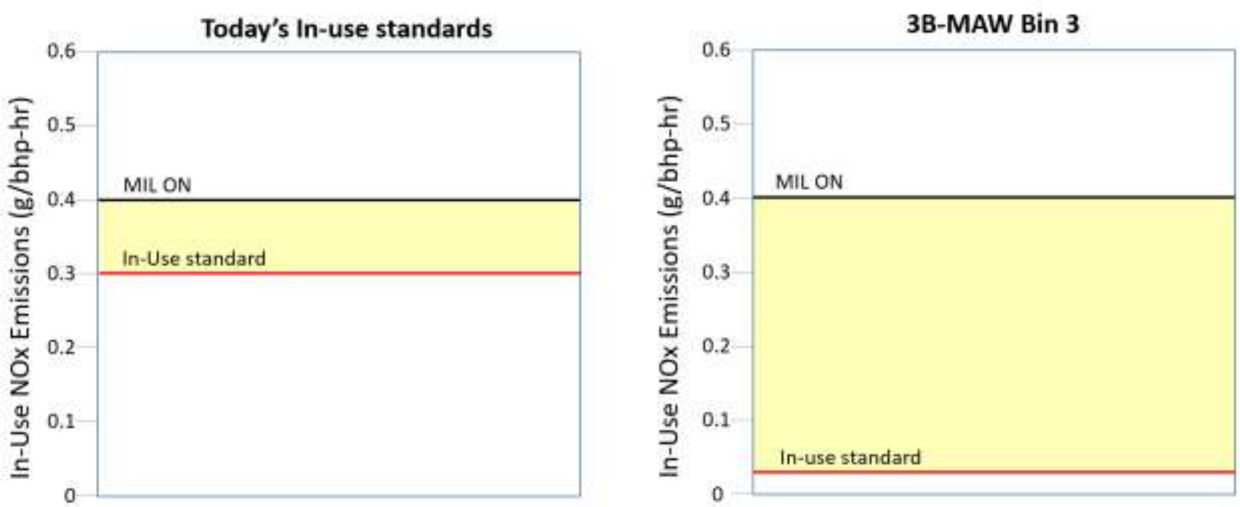
Importantly, these new, stricter pass/fail criteria are imposed simultaneously with the new 3B-MAW in-use emissions protocol and new very stringent standards. EMA believes that there are underlying conditions associated with the totality of the proposed amendments that make it unreasonable to impose stricter pass/fail conditions on the first phase of testing under an in-use test order. Those underlying provisions include the fact that, for each constituent, EPA has proposed 3 separate evaluations for compliance in the form of the 3 "bins" with distinct standards. Yet another factor that EPA should consider before obligating manufacturers to stricter engine family pass/fail criteria is that manufacturers would be at much greater risk to recruit vehicles for testing that have a component failure in progress to the point of exceeding the in-use standards, but not yet progressed enough to have exceeded the threshold required to illuminate the OBD MIL. This much greater risk of recruiting such a "pre-MIL" vehicle, as well as tripling the number of standards against which compliance must be demonstrated under a broader range of operating conditions, should be considered when establishing the pass/fail criteria.

Today, the OBD "MIL-ON" emissions threshold requirement of 0.40 g/bhp-hr is 33% above the in-use NO_x NTE standard of 0.30 g/bhp-hr. Since emissions rates during an NTE window tend to be lower than during the FTP, the provision that permits a manufacturer to exclude a vehicle from testing if it has an active fault effectively avoids recruiting an engine with a fault-based emissions exceedance into the test plan. Under the proposed Option 1 2031 MY requirements, however, the OBD MIL-on threshold of 0.40 g/bhp-hr is more than 13 times the medium/high bin in-use emissions standard of 0.030 g/bhp-hr.

Under current regulations, EPA clearly intends the in-use test program to be an assessment of a manufacturer's product conformance to applicable in-use standards *when evaluated on properly functioning, well-maintained vehicles.* That intention is clear from the vehicle recruiting practices that EPA *requires* under the current regulatory provisions of §86.1908, where a manufacturer "must" select vehicle/engine systems that "have been properly maintained" and "have not been tampered with, rebuilt, or undergone major repair." Importantly, among the conditions a manufacturer must satisfy is that "the engines do not have an illuminated MIL or stored OBD trouble code…" From the foregoing, it is abundantly clear that EPA did not intend for the in-use testing program to include vehicles with engines or aftertreatment systems that are operating in a manner inconsistent with manufacturers' design intent due to, among other things, an emissions-related component fault.

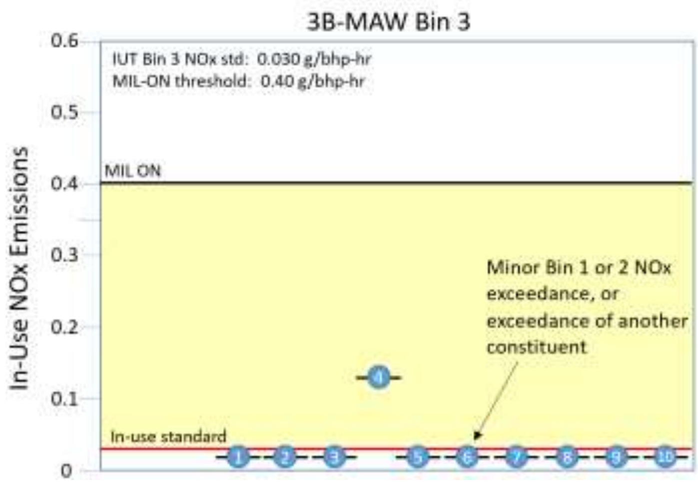
There are other provisions within the HDOH emissions regulations that serve to ensure that manufacturers have designed adequately robust components and systems for emissions control purposes (see emissions related warranty provisions proposed at §1036.120 and emissions defect reporting requirements at §1068.501.) The in-use testing program is clearly intended to confirm that manufacturers have designed and calibrated their *properly-functioning products* for compliant emissions control, which is why EPA requires that manufacturers confirm that recruited vehicles are properly maintained, without active diagnostic codes, and so on. The proposed in-use low-NO_x standards, however, would work in contravention of that fundamental premise of excluding vehicles experiencing emissions-related component issues, simply due to the fact that current OBD systems cannot detect faults until emission levels significantly exceed the proposed in-use low-NO_x standards.

The graphics below illustrate the difference between today's situation and the significantly expanded region of risk manufacturers would face under the proposed amendments. The area in yellow depicts the range of emissions a vehicle may exhibit without a MIL-ON condition, but which could produce a failing result of the in-use test.



To further illustrate the undue risk a manufacturer would face, consider the hypothetical example represented graphically below. In this example, an in-use test order has compelled testing of five vehicles, the fourth of which is experiencing a fault condition that has resulted in a Bin 3

NO_x exceedance of 0.130g/bhp-hr (a level undetectable by the OBD system). The failure resulted in a sixth vehicle test which, in this example, failed the 3B-MAW requirements due to a minor NO_x failure in Bin 1 or Bin 2, or perhaps a minor exceedance of another constituent. The manufacturer would be compelled to test four more vehicles in this case, and average each bin's NO_x emissions from all ten vehicles (see proposed §1036.245). The Bin 3 NO_x results for the ten vehicles in the example are as represented in the chart below.



Example Test Results, Bin 3 NOx:

Veh #	NOx:	
1	0.020	
2	0.020	
3	0.020	
4	0.130	(33% of OBD threshold)
5	0.020	
6	0.020	non-bin 3 failure
7	0.020	
8	0.020	
9	0.020	
10	0.020	
Average	**0.031 FAIL**	

8 out of 10 tests pass easily

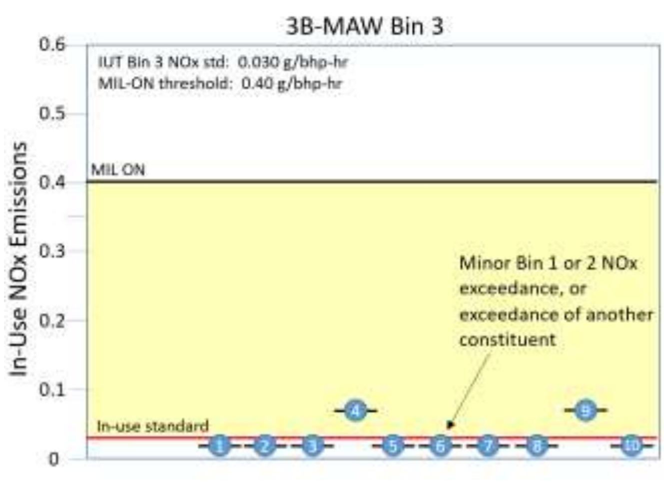
With the exception of a single vehicle exceeding the Bin 3 NO_x limit due to a component issue, and a second vehicle having a potentially minor exceedance in another bin or of another constituent, the engine family in this example is exhibiting excellent emissions control. However, because the average Bin 3 emissions exceeds the 0.030g/bhp-hr NO_x limit, solely due to the fault-driven exceedance measured on vehicle 4, the family would not meet the requirements of the proposed family pass/fail criteria of §1036.425. Today, an exceedance of a percentage-magnitude like that exhibited by vehicle 4 would have excluded the vehicle from the in-use emissions assessment *consistent with EPA's specific intention*. That will change dramatically. The bottom line is that the proposed provisions would subject manufacturers to an increased risk of family-level failure, yet, at the same time, EPA is proposing even stricter family pass/fail criteria. That is untenable.

While it is true that the PEMS measurement accuracy provisions would change the arithmetic in the example above, it would not change the basic concerns with the outcomes. Indeed, the current 0.45g/bhp-hr measurement allowance-adjusted NTE limit is *above* the 0.30g/bhp-hr NTE NO_x standard, providing almost complete assurance of excluding vehicles with engines experiencing an emissions-related fault, just as EPA intended. In contrast, EPA's proposed PEMS NO_x accuracy margin of 10% of the standard (§1036.420(a)(4)), a mere 0.003g/bhp-hr in the case of the Bin 3 standard, would imperceptibly influence the pass/fail outcomes in the example above. It is important to recognize that the measurement allowances are not directly integrated into the relevant in-use standards. They are instead a means to compensate for potential measurement error, avoiding the case where a manufacturer's compliant product is incorrectly determined to be non-compliant simply due to weaknesses in state-of-the-art in-use measurement systems.

There is, then, a very real probability that a vehicle with a faulty or somewhat deteriorated component, a vehicle which EPA found important to exclude from in-use testing when designing the current in-use test program, could be recruited so as to cause, almost on its own, a family failure determination. The only question is the magnitude of that probability. The harsh reality is we do not know, nor does the Agency know, how the introduction of a much more complex technology package, being assessed with a new and very different in-use protocol, at extremely stringent levels, will impact that probability. But what we do know is that it is unrealistic and unreasonable to tighten the family pass/fail criteria in light of this significantly elevated risk.

Considering the foregoing, EMA recommends that EPA *relax*, rather than tighten, the family pass/fail criteria under an in-use test order. Specifically, EMA proposes that EPA replace today's 5/5, 5/6 or 8/10 pass criteria with a passing condition at 4/5 or 5/7 vehicles. If more than 2 vehicles have failed the in-use test requirements after testing 7 vehicles, the manufacturer should be permitted test any number of additional vehicles, up to a total of 15 vehicles (including the original 7), until a passing condition is determined on the basis that the average result for each valid bin is at or below the standard (adjusted for PEMS accuracy) as described in §1036.420(d). At any point in the test program following the condition that more than 2 vehicles out of 7 have failed, the manufacturer should be permitted to initiate discussions with the Agency concerning options available to move forward with actions deemed appropriate by EPA. EMA recommends these "relaxed" family pass/fail criteria to address, at least in part, the increased risk and probability that a pre-MIL vehicle could be recruited into testing under an in-use test order.

EMA's proposal is appropriate and fair considering all of the circumstances mentioned. If EPA were to simply retain the 5/5, 5/6 and 8/10 family pass/fail criteria in place with today's in-use test program, overly punitive outcomes would result. A second example makes this clear. Consider the hypothetical test order results below. After testing 10 vehicles, two vehicles (vehicles 4 and 9) have Bin 3 NO_x exceedances of 0.040 and 0.050 g/bhp-hr, at least one of them due to a component failure not severe enough to be signaled by an OBD MIL, and a third vehicle has a mild exceedance in another bin or of another constituent. Even with an 8/10 pass threshold, this high-performing engine family would nonetheless fail the in-use test assessment. The Agency should seriously consider whether this level of in-use performance justifies the potential of an emissions-related recall, especially given the real possibility that the results will have been unknowingly influenced by a pre-MIL vehicle.



Example Test Results, Bin 3 NOx:

Veh #	NOx:	
1	0.020	
2	0.020	
3	0.020	
4	0.070	(18% of OBD threshold)
5	0.020	
6	0.020	non-bin 3 failure
7	0.020	
8	0.020	
9	0.080	(20% of OBD threshold)
10	0.020	
Average	**0.031 FAIL**	

7 out of 10 tests pass easily

In light of the foregoing, EMA recommends that EPA implement the MY 2027 and later in-use program in a manner consistent with the current principles that restrict the in-use assessment to vehicles that are operating according to manufacturers' design intent. The only way to protect against the increased risk manufacturers face given current OBD detection capabilities, a risk that puts the in-use testing program at odds with those long-standing principles, is to relax, rather than tighten, the engine family pass/fail criteria. EMA believes that our recommended pass/fail criteria would largely fulfill the preservation of those principles in a fair and reasonable manner.

d. There are other aspects of the vehicle recruiting program and reporting requirements that require revision

EMA supports that EPA is maintaining similar requirements regarding vehicle recruiting routines, test processes, and reporting requirements to those that are in place today. There are, however, a few important issues in the proposal that the Agency should address before finalizing the regulation.

The first of these issues is with respect to the timing of the submittal of test plans in accordance with proposed §1036.410, and the various alerts and reporting requirements in proposed §1036.430. Regarding test plans to be submitted to the Agency, it is unclear whether the manufacturer must wait for EPA to approve the test plan before proceeding with setting up and executing the first tests. If EPA would require that they approve the test plan before it gets underway, EPA should specify that they will provide approval of, or specify changes to, the manufacturer's test plan within 30 days of its submittal. It is also unclear how EPA plans to coordinate with CARB on test plan approval to be sure to meet the 30-day response time.

EMA recommends that EPA permit manufacturers to install an "activity monitor," a physical device, on a test-candidate vehicle, where the device is capable of collecting data that determines bin-counts in each bin for that vehicle, and any additional information that would be helpful to the vehicle-recruiting process. The device could be prohibited from collecting any emissions data. Such an activity-assessment tool will improve a manufacturer's chances of recruiting vehicles that will successfully meet the bin-count requirements without multiple days of testing. EMA is available to help develop the complete list of acceptable activity-based parameters.

Also with respect to timing and scheduling, EMA recommends that EPA (and CARB) issue annual in-use test orders earlier in the year than is the current practice. With the proposed 18-month period within which a manufacturer must satisfy all the requirements of the test order (from the date of plan approval), there is a significant benefit to manufacturers' ability to complete these requirements if the test orders are issued early in the year. More specifically, a manufacturer has a better chance of completing the testing over a period that includes a single winter rather than two winters if the test orders are issued sooner. Winter tests include the complication and inconvenience of PEMS installation and support in undesirably cold weather conditions, which can also introduce complications for PEMS performance and function. Winter tests also run a higher risk of inclement weather disrupting travel logistics for the manufacturers' test technicians, as well as last-minute interruptions to vehicle scheduling and completion of the shift-day as planned. Those complications and potential planning disruptions could be avoided if EPA and CARB issued in-use test orders by February 1^{st} each year.

Regarding the various notifications described in §1036.430(c), those also do not include clearly stated requirements as to reporting deadlines from the actual events described. EMA recommends that manufacturers be required to submit any of those notifications within 30 days of the triggering event.

In proposed §1036.415(b)(1), EPA maintains the options to deal with a vehicle that has an illuminated OBD MIL or stored trouble code. Those options are fully appropriate because, as stated in the previous section, EPA's intention with the manufacturer-run in-use test program is to assess emissions compliance on vehicles with "healthy" emissions control systems, operating according to manufacturers' design intent. However, EPA stipulates that, "You may disqualify the vehicle only if MIL illumination or trouble code storage exceeds 12 hours." There is no reasonable justification for this minimum 12-hour constraint to be a condition for excluding such a vehicle from testing. If the OBD system has identified a component or system issue for which the manufacturer is compelled (by EPA's OBD regulations) to illuminate the MIL, why is the duration of the MIL illumination, or the time since a trouble code was stored, a material issue at all? A fault is a fault, regardless of whether it was identified one hour ago or 12 days ago. The emissions control system should be deemed as being in a compromised condition, so it should be disqualified from testing. Accordingly, EPA should not include the sentence regarding the 12-hour minimum condition in the final regulation.

EMA also recommends that a manufacturer be permitted to test a vehicle for more than a single test-day, even if all the requirements for a valid test are fulfilled at the end of the first test-day. Vehicle emissions can vary from one day to the next, subject to influences of ambient conditions, traffic conditions and, most especially, vehicle operation. With this degree of variability, it is conceivable that, on a given (first) test-day, a vehicle could have operated at the high end of its variable emissions performance. Supplementing the data with additional test-days could provide a more comprehensive view, a more representative picture of the vehicle's overall on-road emissions performance. For this reason, EMA recommends that manufacturers be permitted to conduct additional testing if the manufacturer elects to do so. Today, there is a similar provision in §86.1910(h), where EPA permits that, "You have the option to test longer than the two shift-day period described in paragraph (g) of this section." In a similar spirit, EMA recommends that proposed §1036.415 be revised to include a provision that additional test-days will be permissible at the manufacturer's discretion, whether the vehicle has passed or failed the in-use requirement at the end of any test-day. All additional data accumulated would be combined with, rather than replacing, earlier test-days' data.

In the reporting requirements of §1036.430(a)(3)(ix), EPA proposes to require that "gaps in the 1 Hz data file over the shift-day are only allowed during analyzer zero and span verifications." That is an impractical and unworkable requirement. First, the vehicle's CAN communications are interrupted whenever there is a key-off event. The PEMS may continue to record, but much of the required data provided by vehicle systems is not available during these engine-off events. Second, because PEMS are imperfect devices, it is currently difficult to complete a day of testing without at least one incident of data interruption. In some cases, toward the end of a test day, the FID may exhaust its fuel supply, terminating measurement capability. The provision as drafted is outside the test technician's control and should be eliminated in the final rule.

Another item of concern relates to EPA's proposed §1036.430(a)(3)(ix)(O), where it would be required, for each vehicle tested, that manufacturers provide 1 Hz data for "any parameter sensed or controlled to modulate the emissions control system or fuel injection timing." That requirement simply cannot be fulfilled. There are hundreds if not thousands of calculations performed in the ECU that contribute in some way to engine and aftertreatment control that would be subject to this requirement. SAE standards J1939 and J1979 would require updating to include this multitude of parameters, which, in reality would be an impossible task given that each manufacturer has its own set of control algorithms. The requirement is unworkable, and should be eliminated in the final rule.

EPA describes the proposed pass/fail criteria for an individual test article in §1036.420. The engine passes the requirements if the bin emissions result is equal to or less than the relevant bin standard for each constituent after accounting for the relevant measurement allowances. EMA recommends that EPA describe the sum of the in-use standards and their relevant measurement allowances as in-use "thresholds," to avoid confusion with the in-use standards. This would be consistent with the current practice related to NTE in-use standards and thresholds as described in §86.1912. The proposed §1036.420(c) refers to "windows" and "valid windows" interchangeably, without defining what characteristics provide for a valid window. Also §1036.420(d) provides that, "having no valid bins for a bin category over a shift-day does not disqualify an engine from pass-fail determinations under this paragraph (d)." It is unclear what EPA's intention is with provision. It is unclear what a "bin category" is, or what it means to "disqualify a vehicle from pass-fail determination under this paragraph (d)", where the cross-reference to paragraph (d) is unclear. EMA needs to have the opportunity to understand the intention behind this provision before we can comment further.

Finally, EPA has introduced an option whereby manufacturers may use NO_x sensor-based in-use test data instead of PEM-based emissions tests. EMA supports the interest to use on-board sensor technology in this manner. There are several issues that require consideration for this process to be workable, however, including how to account for NO_x sensor accuracy, CO_2 emissions estimation, the quantity of vehicles to be tested, the duration of the "test period" in question (the test-day equivalent), and others. EMA is nonetheless pleased with the opportunity to work with EPA between now and the final rule to develop workable solutions, if possible.

Overall, the various requirements that EPA has proposed regarding manufacturers' interaction with EPA in completing an in-use test order are reasonable and well stated. That said, the foregoing recommendations need to be implemented in the final rule.

8. EPA Has Not Fully Considered All of the OBD Requirements and Capabilities that Could Frustrate the Implementation of the Low-NO_x Regulations

As noted above, the NO_x emission-assessment capabilities of current OBD systems and sensors could frustrate the implementation of EPA's proposed in-use low-NO_x standards. Simply stated, current OBD systems and sensors are not capable of detecting and flagging emission exceedances at the proposed low-NO_x levels.

Additional OBD issues also arise under the proposed regulations. EPA has rightly acknowledged that the multiple HD OBD requirements amount to real constraints on lowering emission standards, and that revising the current HD OBD requirements and monitoring thresholds as they would scale-down to the proposed low-NO_x standards (i.e., at 2.0 x 0.020 g/bhp-hr) would further hinder the implementation of the technologies and multiple aftertreatment components necessary to achieving the types of low-NO_x targets that EPA seeks to mandate. To mitigate that effect, EPA is proposing to leave the OBD thresholds where they are. (See 87 FR at p. 17527.)

However, it still is not clear at what level of emissions impact a component will need to be measured by OBD systems to determine whether or not it has a meaningful impact on emissions. While that criteria is currently not measured directly against the emissions standard (e.g., a % of the NO_x standard) it is often used as an informal metric of emissions impacts from a component failure. With the new proposed Option 1 NO_x standards set to 0.020g/bhp-hr, a component failure that could have been considered to have no significant impact on emissions might now be considered significant if it approaches the level of the NO_x standard. That could cause the new regulations to have a significant impact on OBD development costs and feasibility, even though EPA intends to keep the HD OBD standards as they are. This is yet another factor that shows the impracticality and infeasibility of the Option 1 requirements.

Even with respect to Option 2, it is very important for EPA to consider fully all of the impacts that the Low-NO_x regulations will have on the myriad HD OBD requirements, and all of the necessary OBD revisions that should be included in the relevant OBD regulations. That necessary consideration will help to promote the implementation of revised HD OBD regulations in the future that do not frustrate the implementation of the Low-NO_x Regulations.

As noted, EPA has tried to account for the technical infeasibility of scaling-down the OBD thresholds in a similar manner to the proposed reduced emission standards by maintaining the OBD thresholds at their current levels — e.g. 2x the existing NO_x standard, and an additive 0.020 g/bhp-hr to their existing PM standard, for final OBD thresholds of 0.40 g/bhp-hr for $NO_{x;}$ and 0.030 g/bhp-hr for PM. However, the current in-use emissions standards also are tied to the certification-cycle emissions standards — e.g. 1.5 x the FTP NO_x-threshold is the current NTE/In-Use emissions testing threshold. Today, that approach for correlating test-cell standards to in-use testing standards leads to an in-use NTE standard of 0.30 g/bhp-hr NTE NO_x, with a 0.15g/bhp-hr additive measurement allowance, for an aggregate in-use NO_x limit of 0.45 g/bhp-hr. The corresponding result, with respect to today's standards, is an effective OBD NO_x threshold of 0.40 g/bhp-hr, at which failed components must be detected and diagnosed. That currently leaves a small gap (0.05 g/bhp-hr) between the two emission values, where a component is required to be diagnosed, before a vehicle equipped with such a component could fail the PEMS-assessed in-use NTE standards.

Under the proposed new low-NO_x standards, however, the in-use NO_x standard would be lowered substantially, to 1.5x an Option 1 standard of 0.020 g/bhp-hr, with a corresponding OBD NO_x threshold (if not adjusted) of 0.040 to 0.100 g/bhp/hr. The in-use PM standards would be similarly reduced. EPA acknowledges that it is impossible to diagnose emission thresholds at those values, and therefore would not require it for OBD at this juncture, but nonetheless is leaving the issue open for a potential tightening of the OBD thresholds through a follow-on OBD rulemaking. It is unrealistic to expect that OBD systems, strategies and calibration schemes will advance to the extent that EPA's proposed low-NO_x standards might necessitate. If a manufacturer cannot diagnose an emissions-control system at such a low NO_x level, then guaranteeing emissions performance at such low levels is inherently infeasible. EPA must take this into account fully before finalizing any new in-use emission standards. In that regard, EPA also should respect its own longstanding position that manufacturers should not be required to implement technologies that they cannot diagnose. Option 1 is clearly untenable in this regard. The Option 2 standards will still need to be adjusted upward to account for these issues.

In the process of determining what emissions thresholds are achievable given the proposed substantial reductions in PM and NO_x, EPA and industry may determine that the state of the art for monitoring key components such as catalytic converters, particulate filters, aftertreatment system sensors, or EGR components will require intrusive monitors. Intrusive monitors temporarily increase tailpipe criteria and GHG emissions when executed. EPA requires the average emissions impact of an intrusive monitor to be included in a manufacturer's certification results (much like IRAFs). As such, the applicable standards either will need to be adjusted even more to reflect those necessary temporary increases, or the OBD thresholds will have to be maintained at levels high enough to not require intrusive monitoring. Without such measures, the current OBD provisions would make the proposed standards even more stringent and infeasible.

There is a similar concern regarding the diagnosis of multi-bed catalyst systems. SwRI has suggested that partial-volume OBD monitoring strategies might be deployed for configurations similar to the Stage 3 prototype system. However, OBD-certification staff have refused to approve partial monitoring strategies when proposed previously by some OEMs. EPA will need to clarify whether there has been a change of policy to account for the advent of systems such as those used on the Stage 3 engine.

EPA is proposing other substantive changes to the Agency's current set of OBD regulations. EMA's comments regarding those other technical issues are set forth below.

a. Proposed harmonization with CARB OBD regulations

EMA supports EPA's proposal to harmonize (as much as possible) to CARB's 2019 OBD regulations, and further supports the overall framework to modernize the OBD requirements in EPA's regulations. Harmonization is key to the success of OBD overall, as it provides the certainty and clarity that manufacturers need to develop and implement more robust vehicle OBD systems.

That said, EMA agrees that there are some CARB provisions that are not well-suited to a federal OBD program. Accordingly, we support EPA's proposals for MST testing and deficiencies, with some exceptions. More specifically, while we support the majority of EPA's proposed deficiency provisions, we believe that EPA should more closely align with CARB with respect to certain of those provisions. In that regard, EPA's deficiency timeline is shorter than that provided under the CARB regulations, and would not allow for retroactive deficiencies. Retroactive deficiencies are key for resolving issues found during Production Vehicle Evaluation (PVE) testing, which may not be immediately apparent. Deficiency fines under CARB's OBD program are sufficiently punitive to facilitate compliance, yet the allowance for retroactive deficiencies provides additional necessary flexibility.

Additionally, EMA has concerns with the proposed incorporation by reference provisions of 40 CFR 1036.810(d), as discussed further below. There are multiple versions of CARB's 2019

OBD regulations. Thus, we request that EPA provide additional clarity as to which specific version is being referenced. EMA also is concerned with the proposal that manufacturers provide additional information that is not required in the California 13 CCR 1971.1 regulations, as this will lead to a lack of both harmonization and standardization across the two regulatory regimes.

b. OBD threshold requirements

As noted above, EMA supports EPA's proposal to harmonize with CARB's determination not to lower the OBD NO_x and PM threshold levels at this time. We agree that more time is needed, as CARB has noted, to fully evaluate the capability of HD OBD monitors to accommodate lower NO_x and PM thresholds, and to ensure adequate time for the development and prove-out of robust systems for both EPA and CARB's OBD programs.

Consistent with CARB's regulatory updates to 13 CCR 1968.2 with respect to the Low-NO_x Omnibus rulemaking regarding engines under 14,000 lbs., EMA recommends that EPA carry forward the standard-relief provisions (e.g., freezing the OBD threshold limits, updating all references to the emissions standard contained within 40 CFR 86.1806-05 and 86.1806-17 (13 CCR 1968.2-equivalent), etc.).

c. Additional OBD provisions in the proposed federal program – health monitors

EPA's proposal to include health system monitors raises significant concerns. OBD is a diagnostic, not prognostic, tool. Proposing to change the function of OBD without robust consideration and prove-out utilizing input from the entire affected stakeholder community, especially in the timeframe being considered, is not reasonable. Accordingly, we request that EPA defer the finalization of health system monitors, and instead implement a pilot program to provide time to fully evaluate the proposed provisions, including an evaluation of the perceived benefits, along with an assessment of the necessary standardization, demonstration, etc. That would be especially helpful since the proposed requirements could result in the potential for false prognostics being broadcast to operators, leading to more confusion for drivers and service technicians.

We also have concerns with the Agency's proposal to include such health monitors in the cab – presumably on the dashboard. Adding another display to the dash, again without adequate prove-out (or standardization), also could contribute to operator distraction and confusion. (See **Exhibit "I"**) We recommend that EPA focus on existing emission-related service information regulatory requirements found in §86.010–38(j), as well as the Heavy Duty OBD and Production Vehicle Evaluation testing requirements found in 13 CCR 1971.1(l)(1), to ensure that truck operators and qualified technicians have access to comprehensive diagnostic and repair information, and that required diagnostic data is properly communicated to generic scan tools.

To date, OBD requirements have led industry to provide standardized OBD data, and key operator displays. The ISO 2575 F.01 symbol and fault code standards are now ubiquitous across products approved by the Agency and offered for sale to the public. In the NPRM, EPA proposes to require manufacturers to provide health monitors that have no standardization model in SAE J1939 or J1979 et. al. to support their orderly development and deployment. The implementation timeframe defined in the proposed rule would require engine manufacturers to invent disparate, proprietary communication methods for instrument clusters and dash displays. In many HD vehicles, instrument clusters and dash displays are controlled by the vehicle manufacturers, who would be required to develop new instrument clusters and dash displays to present the new health monitors to vehicle operators. An implementation requirement without supporting communication standards as a guide will lead to multiple inconsistent efforts across the industry, and increased costs and burdens, all while providing little if any appreciable air quality benefit.

Accordingly, EMA does not support health monitors as a general matter. Moreover, we strongly disagree with the incorporation of such monitors in the absence of communication standards that would provide the methods that can be used by all manufacturers. Without uniform supporting communication standards, manufacturers would face unacceptable risks due to their differing interpretations and methods for implementing the proposed requirements. We recommend that EPA consult with industry, the SAE Truck and Bus Control and Communication Network Committee, and the Vehicle Electrical/Electronic (E/E) System Diagnostic Standards Committee, prior to finalizing new requirements that would require new communications from the engine to new instrument clusters and dash displays.

d. DEF dosing effectiveness

EMA does not support the proposal to use a generic scan tool to measure the effectiveness of DEF dosing. Without either an established industry protocol (e.g., SAE), or a requirement that generic scan tools meet such a common protocol, this proposal sets the stage for varied testing among the various manufacturers, and potentially, safety concerns from using an unregulated generic scan tool with a system that is, necessarily, sealed. Further, regarding the request for comment on whether EPA should make SCR performance tests available via generic scan tools (or another on-vehicle method), EMA does not support this proposal. Making SCR performance tests available via either of those methods is not workable, as it would be extremely challenging for the Agency to develop a robust, standardized public SCR performance test that would fit multiple manufacturers' aftertreatment configurations.

e. Use of CARB OBD approval for EPA OBD certification

We support the proposal to allow manufacturers to continue to use a CARB OBD approval letter to demonstrate compliance with federal OBD regulations .

f. Use of SAE protocols

EMA supports the proposal at 40 CFR 1036.150(v) allowing the option to use J1979–2 for manufacturers seeking EPA OBD approval prior to MY 2027. We further support the interpretation that proposed §1036.110(b) would provide a path for the use of J1979–2 when the proposed program becomes effective. Additionally, EMA recommends that EPA also allow for the use of the SAE J1939 protocol beyond MY 2027.

g. Proposed maintenance information for improved serviceability

As also noted below in our specific comments on the proposed regulations, EMA does not support EPA's proposal to include additional maintenance information in the owners' manual. Many of the proposed service information items go beyond the scope of general information necessary for all users, and could create significant unintended consequences. Most of the service-related information that EPA is proposing to now provide in the owners' manual is already available and provided by manufacturers today, but through specific service databases, guides and other documentation, where different types of information are made available according to specific user skill-sets, warranties, maintenance needs, etc. Further, much of the information at issue is already provided for at a "fair and reasonable cost" (as required by the service information regulations of 40 CFR part 86). Given that this information is already available, we do not understand the need to provide duplicate information in the owners' manual, especially when any such information likely will go beyond the maintenance capabilities of the target audience for vehicle owners' manuals. The proposed inclusion of maintenance and emission controls information along with general vehicle information would give the false impression that more substantive repairs are similar in nature to the general use information otherwise provided in an owners' manual. Further, including service information in the owners' manual would greatly increase the size of the manual – it would result in a manual that is prohibitively large, and would not fit in a typical vehicle glove box or elsewhere in the vehicle without taking up a significant amount of space.

In sum, it is unclear why information that is otherwise available, and tailored to the appropriate audiences, should also be included in a general vehicle owners' manual. While we do not support the proposal to provide such information in the owners' manual, we would not be opposed to providing information in the owners' manual regarding where service information can be found.

h. Use of tailpipe emission sensors

EPA requests comment on whether and how to allow manufacturers to use onboard emission sensors to reduce test burden associated with OBD certification, and specifically with regard to a reduction of the test cell time associated with component threshold testing. The Agency suggested use of NO_x sensor data instead of test cycle NO_x measurements.

Tailpipe NO_x sensors are not a replacement for test cycle measurements. EMA would instead recommend that EPA provide flexible, less prescriptive testing methodologies in the current test cell environment, and allow manufacturers to exercise good engineering judgement during demonstration testing.

i. Hybrid OBD

EMA recommends that EPA retain its current conventional engine OBD certification process for procuring Certificates of Conformity. While not specified in the 13 CCR 1971.1 regulation, for engine manufacturers that are not vertically integrated with the hybrid drivetrain, CARB allows for a dual Executive Order OBD certification process, where both the engine manufacturer and the hybrid drive manufacturer independently submit certification documents for OBD approval for a combined dual E.O. approval. However, this process can be a significant burden for non-vertically integrated manufacturers launching new hybrid solutions. We also recommend that EPA include in-use monitor performance ratio (IUMPR) relief for hybrid applications to keep the IUMPR at 0.1, instead of the higher 0.3 limit.

j. Test-out

EPA has requested comment on opportunities to reduce the OBD compliance and certification costs of the federal program through the use of modeling or calculation-based methods to replace testing requirements. That request also references test-out provisions. However, it is unclear if EPA is seeking comment on potentially eliminating test-out provisions. More clarity is needed regarding this request, and regarding the potential provisions to reduce compliance and certification burdens.

k. Harmonization in SCR inducement strategies

There needs to be better harmonization between EPA's and CARB's SCR inducement requirements for medium-duty and light-duty vehicles. If there is not better harmonization in inducement strategies, customers may be even more confused by inducement, since there could be a proliferation of differing strategies within a single manufacturer (e.g., Class 3 chassis-cert trucks vs. Class 4 dyno-cert trucks). Lack of harmonization also increases the burden on manufacturers, as they will have to integrate multiple inducement strategies when it is much more cost-effective to keep a common control strategy across products.

l. Specific comments on 40 CFR part 1036 regulatory provisions

EMA offers the following comments on the specific OBD-related elements of the proposed regulatory text. Additionally, we request that EPA expressly state which 13 CCR 1971.1 provisions are being referenced in EPA's regulatory provisions. As noted below, there are incorrect references to CARB provisions, which makes it difficult in some instances to review the proposed regulations, since it is unclear which CARB provisions are actually being referenced. That lack of clarity will pose challenges for regulated entities during any implementation of the proposed program.

- §86.010–18(a): "*(a)… Note that 40 CFR 1036.150(u) allows for an alternative communication protocol before model year 2027…*" This paragraph appears to have an incorrect reference; in the proposed regulatory text, the OBD communication protocol-related interim provisions are specified in paragraph (v).

- §1036.110(b)(6): "*(6) The testing and reporting requirements in 13 CCR 1971.1(i)(2.3) and (2.4) do not apply.*" Subsections (i)(2.3) and (2.4) cover aging requirements for diesel and gasoline engines; we believe EPA intended this to be a reference to "the Production Engine/Vehicle Evaluation testing and reporting requirements of 13 CCR 1971.1(**l**)(2.3) and (2.4)…".

- §1036.110(b)(8)(i): "*(i) Data parameters specified in 13 CCR 1971.1(h)(4.2) and (4.3).*" We note that 13 CCR 1971.1(h)(4.3) provides the complete description of freeze frame contents; the reference to subsection (h)(4.2) is not needed and should therefore be deleted. Moreover, expanding the freeze frame to include all of the data defined in (h)(4.2) will significantly increase the non-volatile ECU memory needed to store freeze frames. The SAE J1979-2 specification expands the required number of freeze frames from one to ten per ECU. For ECUs that are at or near their maximum capacity of non-volatile memory, this would drive new ECU hardware (a costly and long-lead time change.) We believe the parameters defined in (h)(4.3) are adequate and appropriate for servicing vehicles. If EPA believes additional parameters are required, those specific parameters should be identified in order to minimize the impact to limited non-volatile memory. We estimate an increase of around 500 bytes of data for this additional data, or a total of five kilobytes per ECU to account for the 'ten freeze frames per ECU' requirement for J1979-2.

- §1036.110(b)(9) and (b)(10): "*(9) Design compression-ignition engines to make the following additional parameters available for reading with a generic scan tool, if so equipped:*"; "*(10) Design spark-ignition engines to make the following additional parameters available for reading with a generic scan tool, if applicable:*" EMA presumes that "if so equipped" and "if applicable" in the aforementioned paragraphs do not compel manufacturers to add the components implied by the listed parameters as requirements. Not all of the terms listed in proposed paragraphs (b)(9) and (b)(10) can be precisely matched to existing content in SAE J1939DA. For example, the broad statement in paragraph (b)(9)(vi) "any additional parameters" cannot be assessed independently, and the proposed air/fuel enrichment parameters requested in paragraph (b)(10)(i) do not appear to be defined in SAE J1939DA. Further, some of the proposed provisions, such as the requirements of paragraph (b)(9)(i), may not reside in the OBD boundary for engine manufacturers. We request that EPA consult with the SAE Truck and Bus Control and Communication Network Committee and the Vehicle E/E System Diagnostic Standards Committee to ensure that each of the requested items listed in the proposed regulations has been defined.

- §1036.110(b)(11)(i): EPA is proposing that manufacturers provide additional information that is not required in 13 CCR 1971.1, thus leading to a lack of harmonization and standardization.

- §1036.110(b)(11)(ii): This paragraph lacks clarity and seems to contain incorrect references to the California regulations:

    - 13 CCR 1971.1(i)(2.3) and (2.4): Manufacturers can send the information at the time of certification; however, it is unclear if EPA intended to reference the OBD Durability Demonstration Engine testing results. This is unclear because 13 CCR 1971.1(i)(2.3) and (2.4) cover vehicle selection, and specifically aging. We recommend that EPA consider instead referencing "the Monitoring System Demonstration Requirements for Certification provisions of 13 CCR 1971.1 (i)".

    - 13 CCR 1971.1(l): This provision covers post-production engine evaluation testing, which cannot be provided at the time of certification. Such information, however, can be provided per the deadlines set out in 13 CCR 1971.1.

    - 13 CCR 1971.5(b): This provision is specifically for "Testing Procedures for ARB-Conducted Testing" – did EPA intend to reference 13 CCR 1971.5(c)? If so, we recommend that EPA specifically state "the Manufacturer Self-Test provisions of 13 CCR 1971.5(c)" for clarity.

- §1036.110(c)(2): "*(2) Diagnostic testing to measure the effectiveness of DEF dosing must be made available for use with either a generic scan tool or an equivalent alternative method (such as an option commanded through a vehicle system menu).*" The proposed provision would require an on-demand test triggered by either a generic scan tool or a vehicle input to perform a DEF dosing test. We recommend deletion of this provision, as such a test could potentially damage the catalysts and may take an especially long time to run until the conditions necessary to actuate the DEF are correct. Further, making this control function available for anyone with a generic scan tool is not recommended due to safety concerns, negative impacts to air quality (e.g., NO_x emissions, DEF spill, ammonia slip, etc.), and the potential for errors in conducting service procedures (and associated additional service actions and increases in repair costs). (See **Exhibit "G."**)

- §1036.110(c)(3)(i) through (c)(3)(iii): Many of the terms used throughout these paragraphs do not appear in the current SAE J1939DA protocol. Again, it is requested that EPA consult with the SAE Truck and Bus Control and Communication Network Committee and the Vehicle E/E System Diagnostic Standards Committee to insure each of the items that EPA proposes to request are defined. Specifically:

    - Health monitoring specific metrics are not currently defined in SAE J1939DA.

    - Proposed paragraphs (c)(3)(i)(B) and (c)(3)(ii)(A) refer to "current and historical"; however, the commonly used terms in SAE J1939DA and J1979DA are "lifetime", "trip", and "operating cycle." Furter, the timeframe for the proposed term "current" is not clear for the data items cited (e.g., is a resettable "trip" context intended, or a "start-to-start" operating cycle context intended?). We recommend that any items that are not currently required in 13 CCR 1971.1(h)(4.2) should not be utilized in EPA's regulations.

- §1036.110(c)(3)(i)(B): "*(B) Indicator of historical and current active and passive regeneration frequency.*" Passive regeneration events are not known, and thus should not be required by the regulations. EMA recommends deletion of "and passive" from paragraph (B).

- §1036.110(c)(3)(ii)(C): "*(C) Information describing any detected flow obstruction in DEF lines or dosing valve in anticipation of triggering an inducement under §1036.111(b)(2).*" This paragraph would require tracking of DEF blockages and actual valve output to determine degradation; however, the DEF hardware may not be able to provide such degradation information. EMA recommends deletion of paragraph (C).

- §1036.110(c)(3)(v): "*(v) Provide current data under paragraphs (c)(3)(i) and (ii) of this section based on a default method of updating or resetting collected data. For example, the current data may include information from the Active 100-Hour Array or Stored 100-Hour Array. The system must allow the operator to perform a manual reset to start collecting new data on demand.*" 100-hour active resets on operator demand are not recommended, as they imply increases in non-volatile memory demand for array resets that cannot be confidently estimated. Writes to non-volatile memory are limited by the technology employed, and multiple non-volatile memory locations are employed to prevent memory locations from overuse. Further, on-demand resets need not include any 100-hour stored values. 13 CCR 1971.1 (h)(5.3.5) and (h)(5.7.3-4) require 100-hour active arrays to reset with a code clear command, and prohibit resets for stored 100-hour and lifetime array values. Inclusion of an operator-initiated 'clear fault' command is also not recommended, as previously noted in these comments.

- §1036.110(d)(3) and (d)(4): EMA requests that EPA provide clarity on the allowance for deficiency carryover and retroactive deficiencies (namely for small errors, as manufacturers do utilize retroactive deficiencies routinely and frequently). As noted above, we strongly recommend that EPA harmonize these specific deficiency provisions with those of CARB.

- §1036.111(b): With regard to the proposed fault conditions of paragraph (b), we note that it is critically important that sufficient notification be allowed before applying inducements. We offer the following additional comments on the specific proposed provisions of this paragraph:

  - (b)(4): "*(4) Open circuit faults related to the following: DEF tank level sensor, DEF pump, DEF quality sensor, SCR wiring harness, NO_x sensors, DEF dosing valve, DEF tank heater and aftertreatment control module.*" NO_x sensors should be removed from the proposed open circuit faults of paragraph (b)(4), as the NO_x override factor is part of the derate engagement (specified at proposed paragraph (c)).

  - (b)(5): "*(5) Monitor for a missing catalyst.*" Regarding the proposed provision that monitoring for a missing catalyst be a trigger for inducement, EMA recommends that EPA consider adding specific language for dual-SCR technology (specifically, for a singular failure versus both failing). However, at the very least, we request clarity on how dual-SCR technologies would be treated.

- §1036.111(c): EMA does not support the proposed "within 10 percent" NO_x override factor of paragraph (c) and the use of only Bins 13 and 14 to calculate the override factor. EMA recommends that a better approach is for the NO_x override factor to start from +/-15% which is the standard test-out requirement, and then include the accuracy of commercially available NO_x sensors. Emissions lab data indicates that 15% is a reasonable value for normal testing variation. Considering commercially available NO_x sensors accuracy is +/-10% to +/-15%, +/-25% is a reasonable value for the override factor; +/-15% accounts for normal testing variation, and +/-10% accounts for NO_x sensor accuracy and impact to binned NO_x values.

- §1036.111(g)(1): "*(1) Evaluate whether the detected fault condition continues to apply and reset the Active 100 Hour Array in the OBD system when the fault condition no longer exists. Deactivate derates if the engine confirms that the fault condition is resolved and the override factor for NO_x conversion efficiency is at or below 0.10 for a full inducement drive schedule.*" EPA's proposed reset differs from CARB's requirement at 13 CCR 1971.1 (h)(5.3.6) to pause and resume data collection, while (for (h)(5.3.6)) employing the MIL-on bin (bin 17). We note that the proposal directly conflicts with the 13 CCR 1971.1 requirement that was incorporated by reference. Further, EMA recommends that EPA not make the proposed changes. However, in the future, if EPA wishes to make such changes: (i) it is imperative that the Agency coordinate with both CARB and the SAE standards committees to ensure standardization; and (ii) paragraph (g)(1) should be amended to state "Deactivate derates if the engine confirms that the fault condition is resolved ~~and~~ or the override factor for NO_x conversion efficiency is at or below 0.10 for a full inducement drive schedule".

- §1036.111(g)(2): "*(2) Allow a generic scan tool to tentatively deactivate inducement-related fault codes while the vehicle is not in motion. Reactivate the derate at the same point in the derate schedule if the engine detects the same fault condition during a full inducement drive schedule.*" EMA understands that this proposed capability may be implemented at the manufacturer's discretion. At issue is the fact that whether within the four hours proposed in paragraph (g)(2), or the 80 hours proposed in paragraph (g)(3), there is no warning buffer if a similar fault code is detected within thOse warning periods, and the language indicates that you go back to wherever you were on the derate schedule (i.e., an operator believes that all is well, yet derate begins with little to no warning). This poses both a significant safety concern and contributes to customer dissatisfaction, as noted in previous comments cited throughout the preamble. EMA recommends that EPA consider a warning "buffer" or a specific hour requirement before activating derates.

- §1036.111(g)(3): "*(3) Treat any fault condition that recurs within 80 hours of engine operation as the same triggering condition, which would restart the derate at the same point that the system last deactivated the derate.*" 80 hours represents up to 4,000 miles of travel; dual 125-gallon fuel tanks may be refilled up to four times in this same time period, and the accelerated derate may be faced by a different operator. This proposed provision would add additional complexity and would likely increase owner and operator dissatisfaction with the impact of the regulation on operations.

- §1036.115: "*(d) Torque broadcasting. Electronically controlled engines must broadcast their speed and output shaft torque (in newton-meters). Engines may alternatively broadcast a surrogate value for determining torque. Engines must broadcast engine parameters such that they can be read with a remote device or broadcast them directly to their controller area networks. This information is necessary for testing engines in the field (see §1036.515).*" EMA is confident that the engine torque and speed parameters currently used to support PEMS today should suffice for this purpose, and asks EPA to confirm this expectation.

- §1036.125(h): "*(h) Owners manual. Include the following information in the owners manual to clarify maintenance instructions and the owner's responsibilities:*" As noted above, we do not support the proposed addition of the items listed in paragraphs (h)(1) through (11) to owners' manuals. These items go beyond the scope of general information provided to all users, and more detailed service-related information is available via other manufacturer-provided manuals and tools. We note that manufacturers are already obliged by the service information regulations of 40 CFR 86.010-38 to make such information available, thus manufacturers are already providing this information publicly. While we do not support the proposal to also provide such information in the owners' manual, we would not be opposed to providing information in the owners' manual regarding where service information can be found.

- 1036.810(d)(1)-(2): As noted, the proposed provisions to incorporate CARB's "2019" regulations by reference are confusing, as they lack clarity of which specific version is being incorporated. We recommend that EPA instead specific the regulations by their specific date of finalization, to ensure that there is not confusion about which version of the regulations EPA is incorporating.

9. EPA Should Set Higher Interim In-Use Standards

For all of the reasons discussed above, higher interim in-use standards for NO_x (i.e., using a 2x conformity factor as opposed to a 1.5x conformity factor) are warranted for the first several model years after the new low-NO_x standards take effect in MY 2027. EPA has implicitly conceded as much in "soliciting comment on providing engine manufacturers with higher (numerical) standards for an interim period to gain experience with the additional emissions control technologies needed to meet the proposed Heavy HDE standards (and their rates of deterioration) while those technologies are operating in the field." (87 FR at p. 17563.) EPA further explains the clear justification for higher interim standards, as follows:

> Manufacturers could use the interim period to collect data from field-aged engines in a range of applications to inform how the engines can be designed to meet the standards throughout useful life for all applications in which the engine is used. In setting the duration of an interim period, we would consider how long it would take manufacturers to collect field data from engines operating out to the full useful life mileage ultimately finalized in this rule. (Id.)

EMA fully agrees with the Agency's assessment of the need for higher interim in-use NO_x standards. The known and unknown risks of early model-year product non-compliance are too great without a reasonable phase-in of the final in-use low-NO_x standards to allow for a robust assessment of how the new Stage 3-type systems will age and perform out to the new extended UL and warranty periods. To address those risks, EMA recommends setting the interim in-use NO_x standards by applying a 2x in-use conformity factor for the first seven model years following the implementation of the new low-NO_x standards (i.e., through and including MY 2033). Thereafter, the in-use conformity factor could drop to 1.5.

10. EPA Should Not Reopen the Phase 2 GHG Standards

EMA's earlier comments discuss why the Agency should not unilaterally reopen the Phase 2 GHG standards, and how the proposed low-NO_x standards will negatively impact CO_2 emissions and will increase the technical challenges of meeting the Phase 2 GHG standards in 2027. In short, there is no sound policy or technical basis for the Agency to re-trade the terms of the final Phase 2 regulations at this juncture. To do so would jeopardize all future "final rules." Beyond this critical issue impacting what "final" rules will mean going forward, other more detailed aspects of the Agency's proposed "reopening" nonetheless warrant additional comment.

The August 2016 Regulatory Announcement that accompanied the release of the Phase 2 GHG rule proclaimed that the "technology-advancing Phase 2 program goes beyond the successful Phase 1 program, with standards based not only on currently available technologies but emerging technologies that are not yet in widespread use." (See, EPA-420-F-16-044.) The preamble to the final rule similarly stated that "Phase 2 will include technology-advancing standards that will phase in over the long-term (through model year 2027) to result in an ambitious, yet achievable program that will allow manufacturers to meet the standards through a mix of different technologies at reasonable cost." (See, 81 FR 73481.) Nowhere in the Phase 2 final rule did the Agency indicate that the technology-forcing standards were subject to change if the Agency later felt so inclined.

Since 2016, manufacturers have been preparing to implement the stringent 2027 standards, and the interim standards for model years 2021 and 2024. Manufacturers have developed the necessary engine and vehicle technologies, and they have established production and sales plans to achieve compliance with the increasingly stringent regulatory steps in the Phase 2 GHG program. As the Agency predicted, the Phase 2 program has spurred innovation, and manufacturers have met that challenge by developing and deploying the technologies needed to implement the first step of the Phase 2 rule last year. And with the second step of Phase 2 less than twenty months away, manufacturers are working to deploy the additional technologies necessary to meet those more stringent second-step standards, and then to meet the third and most stringent step of the program less than four years from now. It is clear, then, that manufactures are working diligently to implement the Phase 2 program in a successful and cost-effective manner, just as they committed to do.

In addition, EPA has already begun work on a Phase 3 GHG program, planning to release a proposed rule next year, and a final rule in 2024 that will be effective with model year 2030. The Phase 3 GHG rule will provide the minimally reasonable three years of regulatory stability after implementation of the final step of the Phase 2 GHG program in 2027, and will adopt even more stringent GHG requirements to help transition the industry to ZEVs. Thus, it is also clear that manufacturers face additional technology-forcing challenges to further reduce GHG emissions.

Notwithstanding the aggressive pace and cadence of the HDOH GHG rulemakings, and the corollary technology developments and deployments, the Agency has included in this low-NO_x rulemaking a proposal to "reopen" the Phase 2 GHG program midstream. That reopening proposal is being made in spite of the fact that the new NO_x standards that are the focus of the rulemaking will greatly impact manufacturers' ability to comply with the existing GHG standards, and seemingly ignores the Phase 3 GHG rulemaking that already is underway. Such regulatory destabilization, undermining manufacturers' ability to comply with the requirements, should not be the practice of EPA. If final rules are, in fact, no longer final, the regulatory landscape will be changed in ways that will have very serious repercussions.

To justify the proposed re-trading of the Phase 2 GHG program, the Agency broadly speculates about where the diverse and complicated market for medium- and heavy-duty ZEVs is headed. But in that speculation, the Agency fails to take into account the three separate challenges that must be addressed simultaneously to successfully grow the market for medium- and heavy-duty ZEVs. First, manufacturers must develop diverse ZEV products that will meet their customers' needs. Second, those customers must be prepared to purchase and deploy the ZEVs, and they must be able to do so in a profitable manner. And third, the most expensive and complex aspect of growing a commercial ZEV market is ensuring that robust electricity-charging and hydrogen-fueling infrastructures are in place before the ZEVs are deployed. A three-legged stool is an apt metaphor for the medium- and heavy-duty ZEV market, where available ZEV products, fleets able to profitably deploy the ZEVs, and a robust infrastructure are all three simultaneously needed to support the ZEV market.

Looking only at ZEV product development plans or marketing targets, as the Agency seems to be doing, is a myopic view of a much larger and more complex picture. Stated differently, pointing to a manufacturers' aspiration ZEV marketing plans — something the Agency should be applauding — is not a basis for the Agency to unilaterally undermine the established regulatory structure under which this industry operates. Changing the rules halfway through the game should not be a practice of the federal government. If it becomes such, there will be no reason restraining the industry from encouraging more of the same each time a new Administration takes control.

Undeterred by its proposed breach of regulatory commitments, EPA points to the Advanced Clean Trucks ("ACT") rule that CARB finalized last year as conclusive evidence of significant future growth in the deployment of the medium- and heavy-duty. However, the ACT rule only includes ZEV sales targets, ignoring the other two legs of the stool. When CARB approved the ACT rule, it acknowledged that to be successful, CARB must enact regulations to mandate the purchase of ZEVs and that the State needed to build out a robust infrastructure to charge/fuel the ZEVs. (See, CARB Resolution 20-19.) Since the ACT rule will not begin mandating the sale of ZEVs in California until 2024, and the State is still working on the other two legs needed to support the ZEV sales targets, the rule remains far from a proven success. While California leads the nation is developing its medium- and heavy-duty ZEV market, additional expensive and challenging steps must be taken before anyone can honestly say that the transition of California's trucking industry to ZEVs has actually begun.

EPA also points to the Multi-State Zero Emission Medium and Heavy-Duty Vehicle Initiative as evidence of the growth in medium- and heavy-duty ZEVs, and as support for its newfound belief that "final rules" remain such only for industry. However, that initiative is simply a memorandum of understanding ("MOU"), by and among seventeen states and the District of Columbia, declaring that thirty percent of the sales of medium- and heavy-duty trucks in each jurisdiction should be ZEVs by 2030, and 100 percent by 2050. Similar to CARB's ACT rule (but without any regulatory teeth), the MOU ignores the need for fleets to purchase ZEVs or the more challenging and expensive, but absolutely necessary, build-out of electricity-charging and hydrogen-fueling infrastructures to support the ZEVs. Without wholistically addressing the development of the medium- and heavy-duty ZEV market, the MOU is merely an unsupported aspirational proclamation.

The Agency further points to ZEV prototype and demonstration projects as establishing the "feasibility and durability of the technology for specific applications." (See, 87 FR 17595.) But what is left unsaid is whether the projects demonstrate that the ZEVs complete the work demanded by each trucking business with a competitive total cost of ownership. Commercial vehicles are purchased by businesses for the sole purpose of providing a financial return on the investment in the new vehicle. To invest in a ZEV, the fleet must be able to predict that the vehicle will have a competitive total cost of ownership over other available technologies. Right now, ZEVs have much higher acquisition costs than other technologies, they have lower utility (i.e., the ability to get the job done), and they have lower resale values. Additionally, fleets must invest in new maintenance facilities and parts inventories to support ZEVs, and they must make substantial investments to build out and maintain the necessary charging/fueling infrastructure. Until ZEVs are proven to provide a competitive total cost of ownership for trucking businesses on all of those fronts, they will remain nothing more than a niche market. To be sure, manufacturers are working hard and investing billions to overcome those obstacles, but those efforts do not warrant new interim GHG standards just because EPA feels the need for a new "win." The Phase 3 rule — not this rulemaking — is the regulatory mechanism for helping to deliver on all parties' aspirational ZEV targets.

The NPRM acknowledges the diverse nature of commercial vehicle applications by pointing to the high adoption rates for zero-emission transit buses and school buses. Those narrow applications are highly suitable for ZEVs deployments for various reasons, including that they are operated by government entities instead of for-profit businesses. However, those two applications cannot be used to prove that the diverse private commercial vehicle market is on the cusp of a wholesale transition to ZEVs. Long-haul tractor-semitrailer combination vehicles, concrete mixers, and snowplows are just a few examples of applications that present much greater challenges to the successful deployment of ZEVs. Any realistic assessment of the thousands of unique commercial vehicle applications would conclude that a tremendous amount of effort and resources still remains to be applied to successfully initiate a broad-based transition of the nation's commercial trucking industry to ZEVs.

Nonetheless, EPA highlights the high numbers of ZEV deployments in school and transit bus applications as supposed evidence that when the Phase 2 GHG rule was finalized it underestimated the growth of ZEVs. But again, successful ZEV adoption in those two highly suitable but narrow applications should not be used as evidence that the Phase 2 GHG rule underestimated the growth of ZEV across the board. Certainly, it should not be used to justify increasing the stringency of the "final" GHG standards for more than half of the vehicle subcategories in the Phase 2 GHG rule, nor should those narrow examples be used to reduce the Advanced Technology Credits in the rule.

It is important to note that EPA included the advanced technology incentives at the urging of CARB. CARB advocated to EPA that the "credits are still needed to promote the wide-spread adoption of advanced technologies in the medium- and heavy-duty sectors, which CARB believes is essential to meeting our GHG and criteria pollutant goals." (See, Letter from CARB to EPA and NHTSA, June 16, 2016.) Based on a detailed analysis of the costs of BEVs and FCEVs, the letter also stated that credits alone will not be enough to incentivize production of the technologies, concluding that the costs exceed the benefits of the credits even before factoring in the ZEV infrastructure costs. CARB's analysis remains accurate; to spur ZEV production, the credit incentives must be part of a broader suite of incentive and infrastructure funding. EPA should continue to follow that advice, as the Agency did during the "finalization" of the Phase 2 GHG rulemaking.

The Agency's speculation that it underestimated the growth of ZEVs is not well-founded. Even if it were, it does not justify changing the final Phase 2 rule after manufacturers have established their technology and product plans to meet the rule. Furthermore, regulations as complex and the Phase 2 GHG rule are never perfect. For example, the rule assumes significant GHG reduction benefits from manufacturers deploying electric accessories, a benefit that can only be achieved by increasing the voltage of the electrical system. However, that cannot be cost-effectively accomplished unless a significant portion of the industry also converts to the higher voltage, so accessories can be sold in high volumes. While there has been a great deal of discussion about converting medium- and heavy-duty trucks from 12 V to 48 V, that upgrade is not expected to be realized this decade. As such, manufacturers cannot expect to see any penetration of electric accessories, even though the rule assumed significant adoption by 2027. Because the industry is converting to 48 V slower than EPA assumed when it finalized the Phase 2 GHG rule, manufacturers must deploy other technologies to meet the standards.

The Phase 2 GHG rule also assumed that manufacturers would deploy advanced transmission shift strategies and show those benefits with powertrain certification testing. While manufacturers indeed are deploying advanced shift strategies to make their trucks operate more efficiently (i.e., with lower GHG emissions), they are unable to get credit for that technology when certifying trucks to the Phase 2 GHG regulations. The powertrain certification test procedures are extremely complicated and so far unvalidated. Manufacturers are working with EPA to clarify the procedures so they can conduct powertrain testing consistently and with confidence, but that process is likely to take months or years to complete, and in the meantime, manufacturers have no way of earning GHG credits for the advanced shift strategies they are deploying.

The Phase 2 GHG rule also overestimated the willingness of trucking fleets to accept tamper-resistant automatic engine shutdown systems. The rule assumes that a vast majority of trucks would be built with that technology by 2027, yet even though all manufacturers have the technology available, almost no fleets are willing to accept it. Similar to the other situations where the Phase 2 rule over-estimated the adoption of a technology, in order to meet the current Phase 2 standards, manufacturers must deploy technologies other than tamper-resistant automatic engine shutdown systems. Thus, notwithstanding the other clear examples of the Agency's over-estimations of available GHG-reducing options, EPA is pointing to one potential under-estimation in the Phase 2 rulemaking as supposed justification for recasting what final rules really mean. There is no good faith justification for that.

In sum, EPA incorrectly points to speculative ZEV adoption rates to support the assertion that the Phase 2 GHG rule underestimated the growth of medium- and heavy-duty ZEVs, and that such an assumed underestimation justifies reopening the Phase 2 GHG standards. The actual deployment of ZEVs (not predictions or aspirations) simply does not support *increasing* the stringency of the Phase 2 GHG rule. To the contrary, verifiable sales data would support *deceasing* the stringency due to the rule's overestimation of the adoption of conventional vehicle technologies.

More important than estimation errors in a complex rulemaking, manufacturers need regulatory stability and predictability – now and with future Administrations – to be able to develop the needed technologies and establish the necessary productions and sales plans to comply with the rule. Accordingly, EPA should not reopen the Phase 2 GHG rule; it is a misguided proposal that is wholly unsupported by the relevant facts and the dictates of good government policy.

11. The Proposed Certification and Compliance Provisions Would be a Barrier to the Adoption of Medium- and Heavy-Duty ZEVs

As discussed above, ZEVs are beginning to emerge in the medium- and heavy-duty trucking industry, yet many significant challenges remain for manufacturers, fleets, utilities, governments, and other stakeholders before we can point to the beginning of a broad-based transition of the industry to ZEVs. While aspirations are quite high right now, a great deal of work remains before trucking fleets will be willing to make the significant and long-term investments needed to begin transitioning to ZEVs in a meaningful way. At this time, most medium- and heavy-duty ZEVs in service are prototypes or demonstration units that are a long way from providing trucking businesses with the competitive total cost of ownership that they need to justify beginning the process of converting to ZEVs.

The NPRM proposes to reduce the barriers to ZEV adoption by allowing BEVs and FCEVs to generate NO_x credits beginning in model year 2024. EMA endorses that strategy as a way not only to incentivize ZEVs, but also to provide manufacturers additional product planning flexibility to meet the NO_x standard. However, the NPRM also proposes to impose on credit-generating ZEVs a suite of excessively complex, burdensome, and expensive certification, durability, useful life, and warranty requirements. In that regard, the NPRM includes entirely new certification and compliance requirements that, as written, appear to be impossible to implement. Even if a manufacturer could meet all the proposed regulatory requirements, the certified ZEV would be so expensive that no fleet would be willing to invest in it. The proposed requirements are likely to end up creating two distinct classes of medium- and heavy-duty ZEVs. Credit-generating ZEVs would be burdened with excessive certification, durability, useful life, and warranty provisions, making them commercially non-viable. Conversely, manufacturers would be free to customize non-credit generating ZEVs to meet their customers' needs most efficiently. That unlevel competitive playing field would splinter and hamstring the nascent medium- and heavy-duty ZEV market, rather than promote ZEV sales.

EPA has developed the proposed new ZEV certification, durability, useful life, and warranty provisions without any consultation with the manufacturers that are expected to implement them. History has shown that such unilateral development of complex vehicle certification procedures rarely leads to implementable and successful regulatory requirements. Although it is unfortunate that industry would be starting with the unilateral proposal included in the NPRM, we request that EPA commit to collaborating with manufacturers to identify a workable path forward for the certification and compliance requirements for credit-generating ZEVs. Considering the limited time before a final rule, and the complexity and novelty of ZEV certification and compliance requirements, we believe an interim approach may be the only realistic path forward. An interim solution could be fashioned to meet EPA's needs while not burdening ZEVs with excessive costs and regulatory requirements. If we can identify an appropriate interim approach, a long-term solution could then be developed as part of the Phase 3 GHG rulemaking. That rulemaking is a more appropriate forum for the in-depth data analyses and technical discussions needed to establish workable and effective long-term ZEV certification and compliance requirements.

12. EMA Supports the Flexibility of the Proposed Deterioration Factor Determination Procedures, But Recommends Several Improvements

EPA is proposing new test procedures to determine deterioration factors ("DF") for certification purposes. The most onerous of those new requirements is a manufacturer's obligation to conduct DF testing for the Full Useful Life ("FUL") of the engine's primary intended service class, rather than using extrapolation as is permitted today. The limitations caused by FUL testing are significant, resulting in increased development costs, but more importantly such extended testing requirements present multiple challenges to OEMs' product development, verification and certification timelines. EPA's new requirements would be tempered somewhat by the flexibility manufacturers are given in defining aging cycles, and OEMs' option to bench-age aftertreatment systems, which would allow a much more favorable timeline for DF determination. Still, EMA recommends several improvements to these new provisions to make them workable.

The DF test is one of the many tests in a multi-year process to design, build and test for certification demonstrations. The prototype hardware and software included on the DF engine must be of sufficient design and manufacturing process maturity to establish that the test will "represent the deterioration expected from in-use engines over the useful life." (§1036.245) Once the test begins, the hardware and software revisions are frozen for the duration of the test, which has traditionally taken approximately 25-36 weeks for a typical MHDD or HHDD engine, when aged to 35% of FUL.

One undesirable outcome of FUL DF testing is that it requires that the DF test be started earlier on the project timeline, limiting the manufacturer's ability to iteratively introduce newer technologies that could provide additional GHG or emission benefits. EMA recommends that the Agency continue to allow manufacturers to run DF tests to 35 to 50% of FUL, and extrapolate results as is permitted today. Those extrapolated results could be used for certification purposes. A manufacturer could then be required to conduct DAAAC aging on the DF engine's aftertreatment system to FUL, submitting the subsequent FUL emissions data with the next model year's application, which would apply the new FUL DF results.

As mentioned, extending the DF testing requirement to 100% of FUL without extrapolation forces manufacturers to finalize hardware and software designs earlier in the development process. Currently, there is no regulatory flexibility to make hardware or software changes once the DF test is initiated. Because some of the components are necessarily fabricated from pre-production processes, they may, despite being representative of production intent, be prone to premature or even catastrophic failure. If severe, this can force manufacturers to restart the DF test, putting even more stress on an already challenging production launch schedule. EMA recommends that EPA provide greater flexibility to allow manufacturers to make hardware or software adjustments on the DF engine to facilitate timely test completion, while preserving the integrity of the test. This consideration should also extend to address replacement service parts, which may include sensors, catalysts or EGR components.

For example, downpipes and bellows can easily fatigue with extended dyno testing. Those components are not emissions-critical but cannot be replaced without EPA approval. NO_x, PM and NH_3 sensors currently are not robust enough to survive for 435,000 miles, let alone 800,000 miles. In the event of an engine failure that causes the aftertreatment system to be damaged, it would be desirable if the aftertreatment components could be rapidly aged to the last interim emissions measurement point. The bottom line is that EPA should offer more options and flexibilities to recover from those kinds of issues during the course of a DF test.

EPA has traditionally approved accelerated DF aging cycles based on fuel-burned or work-completed equivalent metrics. When defining those aging cycles, manufacturers must balance the severity of the cycle against the design limitations of the individual components to replicate representative in-use wear without causing premature failure. EMA supports that EPA has proposed to allow the use of accelerated aging cycles to manage the total cost and duration of the DF test. EMA also supports that the Agency has not included requirements to stop and restart the engine at intervals during the service accumulation, as this has little or no bearing on the DF results. However, §1036.245(b)(1)(i) requires that the service accumulation "must also include light-load operation (or alternating light-load and high-load operation) representing in-use behavior that may contribute to aging of aftertreatment devices or systems." Light-load operation is not considered to be a contributor to engine component wear or aftertreatment degradation. We recommend that the Agency eliminate the obligation to include light-load operation. For example, the provision could be modified to state, "However, if you anticipate that including light-load operation may contribute to aging of aftertreatment devices or systems, you must also include light-load operation (or alternating light-load and high-load operation)."

EPA has proposed to allow bench-aging of aftertreatment systems as an alternative to traditional dyno-based aging processes. EMA fully supports this approach for HDOH engines, as well as locomotive engines in §1033.245, non-road engines as described in §1039.245, marine engines in §1042.245, and LSI engines in §1048.240. Expanding the utilization of bench-aging would significantly improve the product development cycle, reducing the costs and risks associated with traditional DF demonstrations (especially when extended FUL testing is required), while also improving the opportunity to deploy the latest technologies into the manufacturer's engine and aftertreatment designs. The SwRI-developed DAAAC protocol is an excellent example of a method that can be utilized to support bench-aging. EMA also supports EPA's proposal that alternatives to "EPA-approved" bench-aging procedures may also be approved. In that regard, EMA does not see the need for EPA to define a minimum number of engine hours of dynamometer aging beyond what is required to stabilize the engine and aftertreatment if a manufacturer were to utilize that bench-aging approach. Allowing for bench-aging of the aftertreatment system (after stabilization), without any prescribed minimums of dynamometer aging, would be the most time-efficient method of determining deterioration factors, and would be consistent with the findings of the "Industry DF" program. Such a provision would optimize the opportunities for engine manufacturers to include the latest technologies into their products, and would reduce testing costs and burdens.

An important issue that the Agency has failed to address in its proposal is how a manufacturer must conduct deterioration factor testing, either through dyno-aging or bench-aging processes, particularly in the case where the manufacturer will include major emissions-related maintenance actions to comply with the extremely stringent emissions standards and extended useful life requirements. For example, if a manufacturer recommends aftertreatment system replacement at 300,000 miles (before the 435,000 mile intermediate useful life interval for which results are required by the proposal), the manufacturer should be able to propose an alternative DF test plan, including a test at 300,000 miles, but eliminating the 435,000 mile test interval. Data-fitting processes also need to be reviewed. EMA is willing to work with the Agency to develop appropriate alternative procedures.

EMA also has concerns related to the proposed requirement under §1036.240(c) that, "Your deterioration factors must take into account any available data from in-use testing with similar engines." That requirement is at the same time too vague and overly broad, and is therefore unworkable. It is entirely unclear how manufacturers, having completed a comprehensive, very costly and controlled full useful life DF determination according to the proposed provisions, would "take into account" other "available" in-use data to adjust those results. There is no clarity as to what types of "available" data should be drawn into this analysis, or would be drawn into this analysis by the Agency, under this language. For example, would data acquired by NGOs unskilled in emissions measurement have to be taken into account? Will manufacturers be compelled to review data from field test engines that have undergone numerous component and emissions control software upgrades and incorporate NO_x sensor data from these engines into the DF determination? As stated, this requirement is utterly unworkable, and should be eliminated in the final rule.

Regarding the DF verification procedures of proposed section §1036.246, EMA recommends a modification that will streamline those processes without impacting the integrity of the program. Regardless of the verification procedure selected, it is unlikely that systems will exceed emissions standards early in their useful life. EPA acknowledges this point by not requiring testing for the first two model years of production. EMA recommends extending this principle to the first years of validation testing by reducing sample size requirements in, for example, years 3 through 6. The number of tests required in years 7 and 8 could also be reduced if the results in years 3 through 6 demonstrate sufficiently compliant results. Indeed, it is unclear how relevant slightly elevated levels at early intervals might be. Accordingly, it may be reasonable to provide that a manufacturer has the option to perform these verifications only in the last stage of UL (the 85% of UL stage) if that manufacturer chooses to take the risk of failing results and potential recalls. EMA is willing to work with the Agency to establish appropriate streamlined parameters that will provide the Agency with the same level of assurance the DF verification process was intended to provide, but with reduced overall burdens for manufacturers.

It is noteworthy that the DF verification procedures were originally developed in guidance to confirm the validity of DF's developed through extrapolation of test results based on demonstrations conducted over less than FUL. The application of bench-aging would enable FUL DF determinations. As proposed, the extensive and burdensome DF verification testing requirements do not sunset. Manufacturers would be required to fulfill the DF verification requirements long after bench-aging has been confirmed as a reliable method of determining DFs. EMA recommends that the DF verification requirements sunset no later than 2035.

It is unclear why a manufacturer should be required to include non-emissions deteriorating components (wiring harnesses, DEF tanks and related sensors) when obtaining engine and/or aftertreatment systems for the engine dynamometer DF verification option. EMA recommends that the manufacturer be given more flexibility to propose a reduced list of necessary components.

There are additional DF verification provisions that require clarification. For example, the pass/fail criteria in section §1036.246(d) for all three verification options should clearly state that a manufacturer fails the verification test if "fewer than 70%" of the test samples pass. Additionally, sections §§1036.246(d)(1)(ii), (d)(2)(ii) and (d)(3) instruct the manufacturer to "apply infrequent regeneration adjustment factors as specified in §1036.522." EMA recommends clarifying this language to say "apply infrequent regeneration adjustment factors as included in your application for certification" to avoid any confusion that new adjustment factors should be generated or confirmed. EMA also recommends that EPA include flexibility allowing a manufacturer to propose alternative plans in the event that engines meeting the minimum mileage (or hours, for non-road or other applications for which hours are appropriate) requirements cannot be located or otherwise made available for testing.

The DF verification requirements from 40 CFR 1036.246 are triggered by the initial model year that relied on the DF determined per 40 CFR 1036.245. In the context of a new emissions rulemaking causing multiple engine families to start production in the same model year, the DF verification requirements would prove very burdensome for the manufacturer with no option to delay or stage each of the various stages of the DF verification program. We recommend adding a provision to limit the total number of DF verification test programs a manufacturer would be required to perform during a single year to no more than three (3).

EMA appreciates that EPA proposes to allow aftertreatment bench-aging as an option for DF testing in lieu of traditional dyno-based aging for other regulatory categories beyond on-highway, including nonroad, marine, locomotive, and LSI engines. However, there are significant and unique differences in those regulations, customers, and markets which warrant differences in DF verification requirements compared to on-highway. While EPA seems to have taken some of this into account in the proposal, additional considerations and flexibilities need to be incorporated.

EPA proposes that non-road engine manufacturers may "alternatively determine and verify deterioration factors based on bench-aged aftertreatment." (§1039.245(e)). The existing provisions of (§1039.245), however, apply at the family level. EMA recommends that §1039.245(e) applies only for each DF demonstration, not for all engine families to which DF's were applied through carry-over or carry-across provisions.

For marine engines in §1042.245, a manufacturer should be allowed to propose an alternate verification method, similar to the alternative option (f) EPA included in their guidance document CD-2022-02 for marine DF validation. For example, for any marine engine family that is a direct carry-across from a previously certified nonroad engine family, the manufacturer should be allowed to submit durability-demonstration test data from that nonroad engine family, which will constitute sufficient validation for the DF of the carry-across marine engine family. For locomotive engines in §1033.245, EPA should leverage the existing in-use program in Subpart E that already covers 50-75% of useful life, and only additionally require a single-step DF verification at >85% useful life.

Finally, regarding LSI engines in §1048.240, it is unclear whether the experiences from studies by EPA, EMA, and SwRI, which resulted in the DF validation guidance documents issued by EPA for SCR-based diesel compression-ignition engines, necessitate an additional verification program for LSI. Since LSI has an existing in-use program in Subpart E, EPA should provide data to demonstrate that DF verification is additionally needed for this category.

Regarding the option to perform DF verification by utilizing on-board NO_x sensors, EMA recommends some revisions for the final rule. The first item of concern is the requirement to include at least 50% of the manufacturer's production volume in this assessment. That could amount to a tremendous number of evaluations, all to be post-processed according to the complex 3B-MAW in-use test protocol. The reporting requirements of section §1036.246(f) include numerous details from each test, including VIN and serial numbers, and statements that "tested engines have been properly maintained and used and describe any noteworthy aspects of each vehicle's maintenance history," as well as explanations why data was "invalidated." Such detail cannot be automated for reporting processes. Providing 1Hz data on each test would require voluminous datafile submittals. All of these factors render the "50% of production volume" sample requirement completely unworkable.

EMA recommends that the number of engines to be included under the NO_x sensor-based DF verification provisions be significantly reduced. Reducing the sample size to 20% or even 5% may still be unnecessarily onerous. EMA suggests that EPA use the same quantity of units as mentioned in the DF validation guidance (7 or more per year) if utilizing this DF verification option, or any number of sampling methods available to complete a statistically rigorous assessment in a less burdensome, more cost-effective way. EMA is willing to work with the Agency to propose a statistically sound basis for defining the number of engines to be included. If EPA finalizes the rule with a direct percentage, it should be a direct percentage of the parent engines produced.

With regard to §1036.520, which specifies the test procedures to submit NO_x sensor-based data, including collection of 1Hz data and post-processing results according to the 3B-MAW protocol, EMA is again supportive of this forward-looking approach. There are, however, limitations as to the type of data that can be made available. For example, current telematic systems cannot transmit 1Hz data. CARB intends to modify REAL requirements in future OBD amendments, requiring that REAL include the capability to determine and store bin emissions according to the 3B-MAW requirements included in the Omnibus Regulations (and proposed in the NPRM). But that capability will not be in place until perhaps 2031. In the meantime, it could be possible for EPA to utilize the current REAL capabilities for the purpose of supporting DF verification requirements. Once 3B-MAW results are available, the process could incorporate those results for DF verification and in-use testing purposes.

There are other concerns with the proposed NO_x sensor-based data acquisition requirements. For example, the requirement that on-board measurement capability must be verified as described in §1065.920(b) is unworkable. The replicates test option of §1065.920(b)(6)(ii) would not be available with the 6 to 9 hour road cycle, because that process does not include replicates in the same way that the current NTE-based requirements do when applied to §1065.920. The requirement that the NO_x sensor be active within the first 100s of operation and remain active throughout the day is unworkable. Modern NO_x sensors are not sufficiently robust to withstand all operating conditions, and must be turned off to avoid failure when dew point conditions are experienced in the exhaust stream. The ECU is switched off at key-off, so the NO_x sensors are down under key-off conditions as well. Additionally, there is much to work out concerning CO_2 emissions estimation from fuel delivery, calculation of CO_2-specific results, and many other details. EMA stands ready to work with the agency to develop the appropriate processes to enable NO_x sensor-based data acquisition capabilities.

EMA supports EPA's proposal to allow a manufacturer to reverse a fail determination under the PEMS-based or NO_x sensor-based verification procedures by applying the engine dynamometer-based procedures. This provision provides a reasonable method for addressing the potential shortcomings of the other methods.

EMA also requests that consideration be given to coordinating and streamlining manufacturer activities related to DF verification and the HDIUT program. The EPA/CARB in-use test orders could be scheduled to coincide with DF verification obligations. EMA recommends that the Agency consider this opportunity to reduce manufacturer burdens.

In sum, EMA supports the flexibility offered by the various options EPA proposes in the determination of deterioration factors and the DF verification procedures. However, for spark-ignition engines which utilize the bench-aging option, EMA recommends that the requirement to perform in-use verification testing of the emission Deterioration Factors be eliminated. Spark-ignition engine bench-aging has followed a similar process to spark-ignition light-duty vehicle bench-aging for many years, and the deterioration levels produce by bench-aging are well-aligned with aftertreatment deterioration observed from on-road vehicles. EMA stands ready to work with EPA to develop improvements to streamline those processes in the final rule.

13. Other Technical Concerns Will Need to be Addressed

a. EMA's views regarding the certification cycles

EPA proposes to apply the GHG version of the RMC to the certification testing process for criteria emissions. The effective weighting factors at each steady-state data point for the GHG RMC were developed based on a robust dataset reflective of modern engines. The industry recognizes the importance of representativeness in the certification tests, and agrees it is illogical to make different assumptions about operational activity depending on the emissions constituents measured. EMA supports EPA's proposal to use this improved, more representative test for criteria emissions testing.

EPA also proposes to add a new low-load certification test cell cycle ("LLC") to the certification requirements for HDOH engines. The new LLC, first developed and applied to HD HDOH engine requirements by CARB, is a 92- minute test cycle that includes approximately 30 minutes of idle operation, a significant portion of high-to-low load operation with extreme air-flow-induced cooling (i.e., downhill operation), and a significant portion of low-to-high load transient operation (i.e., drayage work). The selected LLC also has an average power that is approximately 6% of maximum power, and an average vehicle speed that is approximately 10 mph. It is an extreme cycle, especially as applied to every HDOH engine, regardless of the vehicle type and application in which the engine might be installed.

EMA has repeatedly questioned the analyses that CARB, SwRI, and NREL relied on to develop the LLC. One concern relates to the portion of the LLC that has been dubbed, "v11660_5." That portion's combination of engine, transmission, 6x4 axle configuration, and 4.20 axle ratio appears to be a heavy-haul configuration, which should mean heavier parts all around. However, the mass—after SwRI's mass reduction and after EMA subtracts a hypothetical 15,000-pound empty trailer—is 11,333 pounds for a GEM-simulated tractor. That tractor weight is not at all realistic. Even a heavy-haul single unit vehicle, like a dump truck, typically is heavier than 26,333 pounds (i.e., without subtracting an empty trailer). For reference, Navistar's regional-haul day-cab with a roof deflector and a 12-liter engine is about 15,000 pounds, and a Daimler Cascadia day-cab with no roof deflector and a 13-liter engine is 16,300 lbs. Those day-cab configurations are among the lighter Class 8 vehicles, yet they are thousands of pounds heavier than the vehicle simulated to generate LLC portion "v11660_5." Thus, it would seem that the proposed LLC is not representative of the actual operation of any actual HDOH vehicle. EMA recommends that EPA work (with CARB) to modify the LLC to include only representative engine behavior drawn from representative vehicle operation.

Similarly unrepresentative is the LLC auxiliary load that EPA proposes to apply. EPA should increase the LLC auxiliary load for HHD engines from 3.5 kW to a value in the range of 5.0 to 5.5 kW, so that it is more representative of real-world auxiliary loads.

EMA supports that EPA proposes to allow a stop-start function to be active during the FTP and LLC cycles (§1036.501(f)). Stop-start could be an effective tool for reducing NO_x, and having the ability to demonstrate NO_x control over the LLC and RMC will be beneficial. More detail will be necessary, such as whether operator over-ride functions will influence whether stop-start can be active during certification testing. Also, there are concerns about deploying conventional starters to support restart, because the inertia of the dyno may cause unforeseen problems. EMA appreciates that EPA is providing for stop-start to be active in the certification tests, and is ready to work with EPA to iron out the details for the final rule.

Numerous revisions are proposed for GEM modeling in Part 1037. GEM powertrain mapping is an incredibly complex process. To improve the understanding for all, the Agency should provide step-by-step flow charts of the powertrain mapping procedure for ICE, PHEV, and BEV powertrains. Flowcharts would greatly clarify the process, reducing confusion, avoiding wasteful errors, and saving time for both manufactures and the Agency. Similarly, we support the added regulatory flexibility to test hybrid and plug-in hybrid vehicles on either an engine dynamometer or a powertrain dynamometer.

One additional recommendation concerns the engine mapping procedures under §1065.510(b)(5)(ii). The preamble reads:

> Specifically, our proposed update to 40 CFR 1065.510(b)(5)(ii) would require manufacturers to disable any electronic controls that they report to EPA as an auxiliary emission control device (AECD) that would impact peak torque during the engine mapping procedure.

Yet, in proposed §1065.510(b)(5)(ii), there is no such revision. EPA should correct this omission in the final rule.

EPA has requested comment on the proposed SET test cycle and standards for SI HDEs, and whether any modifications should be considered when adapting the current CI-based SET duty cycle to SI HDEs. Application of the SET test to gasoline SI engines will require significant engine and aftertreatment investments far beyond the scope of what EPA has considered in the NPRM. The higher-load operating points of the SET test are challenging for gasoline SI engines where engine and aftertreatment components can be damaged by the associated high exhaust temperatures. Fuel enrichment is commonly used to cool those components under high-load conditions. EPA's gasoline SI demonstration of SET compliance employed down-speeding to avoid fuel enrichment. While down-speeding could be used in these applications, there will be a significant loss in the engine performance that customers demand. EPA states in the preamble that down-speeding would have to be combined with enhanced emissions controls and improved catalyst formulations to meet the proposed standards. EMA believes the hardware and software changes required to comply with the proposed SET standard, while also maintaining the customer's performance requirements, would be far more extensive than that. Indeed, those applications would have to be transitioned to higher displacement engines, requiring potentially significant vehicle modifications to package both engine and aftertreatment systems. An undesired consequence of using higher displacement engines in those applications would be an increase to GHG emissions. Additionally, manufacturers would be required to achieve greater engineering margin to account for the multiple sources of variability present in real-world applications beyond that provided in EPA's test results.

Considering the foregoing, EMA recommends that the SET test requirement be delayed until MY 2031 to provide manufacturers of gasoline SI engines the time needed to develop and install the larger engines that would be required for those applications. Alternatively, the SET test could be introduced with MY 2027 as proposed, but with exclusions to criteria emissions requirements needed during fuel enrichment-supported operation under high-load. Those exclusions could be sunset in MY 2031.

b. The Agency's proposal regarding selection of the test engine is unworkable

EPA's proposed requirements under §1036.235(a)(1) provide that a manufacturer must select an engine configuration for criteria pollutant certification testing that is "most likely to exceed (or have emissions nearer to) an applicable emission standard or FEL…" That requirement could lead to significant ambiguity in determining the selected test engine's configuration, as it is unlikely that one engine configuration would have the highest emissions for all certification cycles and all criteria pollutants. Further, EPA's proposal could result in a different configuration identification, such as a child rating, compared to existing requirements in §86.096-24(b)(3)(ii) which allow selecting "the engine that features the highest fuel feed per stroke, primarily at the speed of maximum rated torque and secondarily at rated speed." EPA should retain the existing criteria based on highest fueling in §86.096-24(b)(3)(ii) (and similarly retain the existing criteria in §86.096-24(b)(2) for Otto-cycle engines) for selecting an engine configuration for criteria pollutant certification testing.

Today, the test engine configuration requirements have led to a situation where some manufacturers use a different test engine configuration for criteria emissions demonstrations than the one used for GHG emissions demonstrations. Proposed §1036.235(a) requires that the data engine for GHG emissions be the same as the data engine configuration for criteria pollutants. This new requirement, as proposed, will have unintended consequences on engine GHG stringency. The engine configuration with the highest NO_x, for example, on an SCR-equipped engine will likely be a lower power rating within the family, and will likely, therefore, have relatively high CO_2 emissions relative to the other ratings in the family. The requirements of proposed §1036.235(a) will thereby have the effect of increasing the stringency of the GHG standards. This is the most serious consequence of the language as proposed. There could also be corollary complications with other aspects of emissions control regulations, such as DF carry-across, where factors such as highest fueling and exhaust flow (catalyst residence time) are deemed relevant.

c. The provisions related to the use of Vanadium SCR systems are appropriate

EPA is proposing to codify the Vanadium SCR requirements currently included in Guidance CD 1609. The proposed provisions of §§ 1065.1113 through 1065.1121 are reflective of that long-standing guidance, and provide reasonable requirements related to the determination of sublimation temperatures for the catalyst formulations proposed for certification. Manufacturers would be required to demonstrate that exhaust gas temperatures would not exceed the critical threshold temperatures, and that the system has the capability to detect upstream failures that might lead to high exhaust temperature.

EMA supports the proposed Vanadium SCR provisions, as applicable to HDOH, non-road and other market sectors. Those catalysts have been shown to be effective for NO_x reduction and may be a key part of OEM strategies to comply with stringent tailpipe emissions requirements. The proposal provides clear methodologies to validate and certify a highly effective SCR catalyst. That said, EMA requests the addition of a provision in Part 1065 that would allow manufacturers to request EPA approval for alternative test procedures. For example, a manufacturer could propose a system-level test with the complete aftertreatment assembly, and potentially include higher exhaust temperatures to demonstrate representative durability and feasibility.

d. EPA's proposal to require closed crankcase ventilation is unnecessary and potentially environmentally harmful

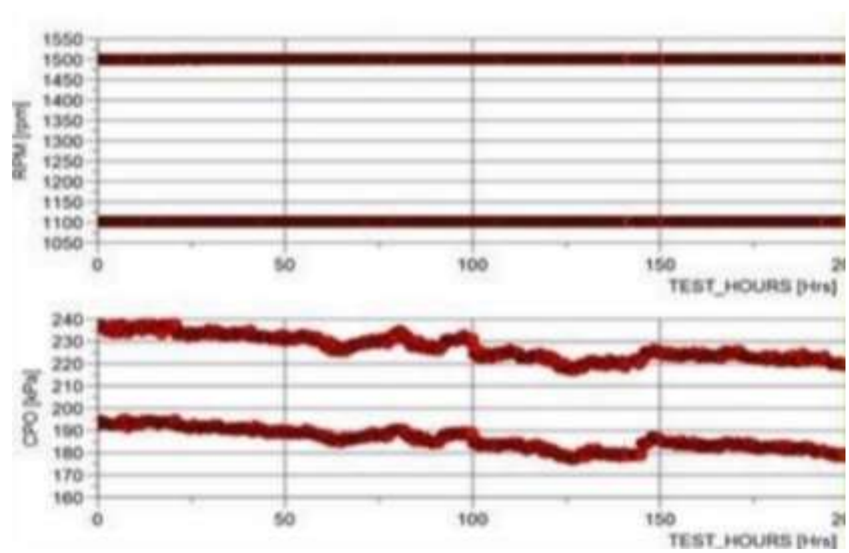
Open crankcase ventilation systems have evolved over the years, now incorporating very effective vapor separation systems. EPA is proposing to require manufacturers to close those crankcase systems. (§1036.115(a)). EMA believes this is an unnecessary development expense to add to this already tremendously challenging and costly regulation, and in fact, could be harmful to engine and aftertreatment durability, contrary to EPA's goal to extend useful life requirements.

Closed crankcase ventilation ("CCV") systems can foul turbochargers, leading to degraded performance and turbo efficiency (increasing CO_2 emissions), as well as potential secondary damage including fouled intercoolers and, as boost is reduced, increased engine-out PM. Increased engine-out PM has multiple undesirable consequences, including increased CO_2 and other emissions levels due to increased regeneration frequencies, as well as accelerated aging of aftertreatment systems. EPA acknowledges many of these potential impacts in the preamble to the NPRM.

The types of failures that can be experienced with CCV systems are more severe than those that can occur with open crankcase systems. Consider a failure of the system that filters the blowby gas. With an open ventilation system, a failure results in a MIL and/or puddling oil on the ground, which both will lead to relatively rapid repair, with no significant impact to emissions before the repair is performed. If, however, the filtration system fails with a CCV system, it can damage the turbocharger, intercooler, and downstream components (if vented to the compressor inlet) or the aftertreatment system (if vented to the exhaust, as EPA suggests). This can turn one relatively simple failure into several more significant and expensive ones, that can directly impact emissions. In fact, the core issue at hand may not even be noticeable or detectable until more serious collateral damage has occurred.

Compressor coking can occur in diesel CCV applications. Coking is most likely to develop with high compressor outlet temperatures under high load. Although CCVs are common in lighter-duty engines, including diesels, heavy-duty engines, especially heavy heavy-duty engines, are much more likely to experience these conditions than passenger cars. Experience with lighter-duty products does not amount to a sufficient feasibility demonstration for heavy-duty engines. The images below show examples of downstream damage to the turbocharger, and the resultant impact to engine boost:

CCV Impact on compressor after 200 h durability cycle using current state of the art crankcase breather with closed crankcase system.



Engine boost deterioration during coking test – 200 hours of exposure to closed crankcase ventilation, showing direct impact to compressor efficiency, resulting in reduced boost.

There also is a slight safety risk for closed crankcase systems that cannot be adequately controlled. Creating a path from the crankcase to the engine intake risks introduction of a potentially uncontrolled fuel source, potentially leading to an engine runaway condition.

More generally, today's open crankcase systems have very little emissions impact. Some manufacturers have evaluated end of useful-life crankcase emissions and found no material impacts. Manufacturers are required to include crankcase emissions in their certification results (either by measuring separately and adding to tailpipe emissions, or plumbing the crankcase ventilation into the exhaust upstream of emissions measurement sampling). The fact that these emissions are measured and accounted for renders any theoretical environmental benefits moot, which means an obligation to close the crankcase introduces only risk, with potential emissions *increases* as already noted. There is, then, no sound basis for EMA to propose this design-based (not performance-based) requirement.

The arguments in the Preamble supporting the requirement for closed crankcase systems include concerns about CH_4 emissions from natural gas engines. EPA directly acknowledges that this is only a concern for natural gas engines, a small fraction of the HD market. Increasing the risks described earlier on all HD engines to reduce CH_4 emissions from a small fraction of heavy-duty engines is not practical or reasonable.

EPA should continue the practice of setting performance-based standards, and this is no less true with respect to crankcase ventilation systems. The emissions contribution at issue is fully accounted for, including FUL impacts through the DF testing process. Robust diagnostics could also be implemented to ensure ventilation system efficiency in-use, consistent with the CARB OBD requirements effective with MY 2024.

In sum, EPA should eliminate the requirements to implement closed crankcase systems on HD diesel engines in the final rule. EPA is effectively proposing to implement a solution to a problem that does not exist, at the risk of creating new emissions-elevating problems. There are no effective emissions benefits, simply unwarranted risks, introduced by this proposed requirement.

e. The ORVR requirements for gasoline engines should be revised

The Agency's proposal includes new evaporative emissions control requirements during refueling. Those requirements, new to HD gasoline vehicles, will require Onboard Refueling Vapor Recovery (ORVR) systems to comply. EPA has requested comment on the proposed ORVR standard level, test procedures, canister conditioning and fuel-rig testing.

Although similar light-duty ORVR hardware could be deployed on heavy-duty incomplete vehicles to meet the new refueling evaporative emissions limits, the large fuel tank and canister sizes of those vehicles present a unique challenge to industry in balancing ORVR and canister BETP emissions. They will also require complete fuel system redesigns on many heavy-duty vehicles. Large scale use of these larger canisters to ORVR and canister BETP requirements has not been demonstrated by industry. Due to the uncertainty regarding the use of the new canister designs, EMA is requesting longer test schedule drive sequences and a heavy-duty ORVR compliance three-year phase-in of 30%, 60% and 100%.

EPA acknowledges that the real-world operating conditions of heavy-duty vehicles are more challenging than for light-duty vehicles (87 FR at p. 17491), and requests comments on possible adjustments to the ORVR test procedure. EMA recommends that an additional FTP-75 drive schedule be added to the 3-Day, 2-Day, canister BETP and ORVR test procedures following the canister load and prior to the drive schedule. That procedure would align with existing approved drive schedules utilized for certification by heavy-duty vehicle manufacturers.

EPA also requested comment on potential adjustments to the canister-load procedure. Manufacturers have several decades of testing experience with canisters loaded to a saturated condition and are uncertain as to any appropriate adjustments regarding the canister-load procedure. To propose an alternate canister-loading condition, extensive testing would be required to determine the correct condition and resulting impact on the emission test results. Due to that uncertainty, EMA proposes that EPA adjust the drive schedules, as proposed above, to better reflect heavy-duty vehicle real-world operating conditions rather than consider adjustments to the canister-load condition.

Also due to the uncertainty of the execution of these new canister designs to meet the ORVR requirements, EMA requests a heavy-duty ORVR three-year compliance phase-in of 30%, 60% and 100%, starting with MY 2027. EPA should also consider an alternative OBD2-style ORVR phase-in schedule, which would incentivize OEMs to certify products to the heavy-duty ORVR requirements as early as possible, and may encourage OEMs to certify 8,501 to 14,000 lb. GVWR incomplete vehicles to the heavy-duty ORVR requirements. CARB provided for an optional phase-in period to comply with the LEV III evaporative and refueling requirements. OEMs found the phase-in to be useful and necessary in transitioning their product lines to the new requirements, and therefore EMA recommends a similar option for HD vehicles.

For fuel system rigs and vehicles that can fit into the existing ORVR SHEDs, the light-duty test procedures with the proposed revised drive schedules, or a bench purge of the canister for rig testing as outlined in the CARB section 12.5.2 BETP test procedure, could be conducted.

Due to the steady-state temperature condition and short duration of the ORVR test, non-fuel-based background emissions do not have an impact on the ORVR test results. Overall vehicle contribution to the ORVR HC mass observed in the SHED is negligible. For example, consider the case of a 1-hour hot soak during the 2-day evaporative test, where the vehicle may emit 0.05g/60min, while also assuming a 50-gallon fuel tank undergoing a refueling test at 9.8 gal/min (assuming a 10% prefill and 1 minute dwell time after nozzle shutoff). Such a case would result in 0.0001 g/gal HC dispensed, less than 0.05% of the ORVR standard. The outcome of this analysis under reasonable assumptions indicates that an adjustment to the ORVR standard is not required to account for the extremely small differences in rig tests and vehicle tests.

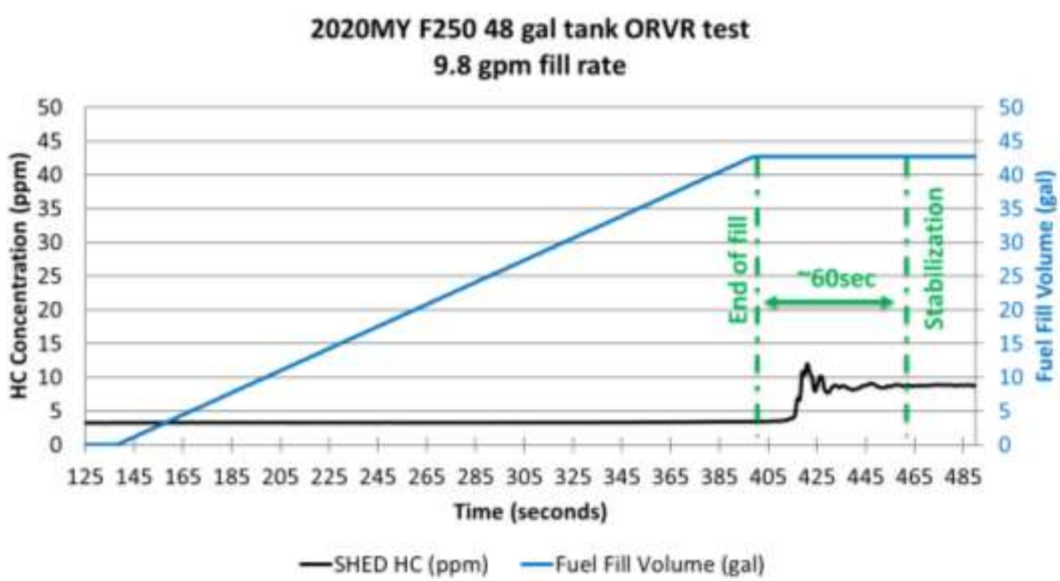
Testing heavy-duty vehicles and rigs can present unique test procedure challenges compared to those involved in light-duty vehicle testing. There are situations where a heavy-duty refueling test must be stopped and restarted (e.g., dual fuel tanks with separate filler tubes or fuel dispensing constraints). For testing those systems, EMA recommends following the ORVR light-duty vehicle test procedures with the proposed drive schedules, but further recommends treating the actual refueling portion of the test as two separate fueling actions. More specifically, EMA recommends the following provision:

Measure the hydrocarbon increase in the SHED for each refueling action. Sum the two hydrocarbon increases and divide by the total amount of fuel dispensed for both ORVR refueling events.

The revisions to the test procedures and the ORVR phase-in schedules proposed by EMA should be taken into consideration by EPA for future rulemakings that are applicable to 8,501 to 14,000 lb. GVWR incomplete heavy-duty vehicles. EMA also recommends that EPA clarify that the ORVR requirements would be applicable to vehicles that operate on volatile fuels, but exclude diesel-fueled vehicles.

EPA is proposing to use engineering analysis for heavy-duty ORVR compliance in lieu of demonstration testing (87 FR at p. 17491). EMA supports that proposal, which is reflective of existing practice in the current HD regulations. EMA also supports EPA's proposal to align heavy-duty ORVR useful life requirements with the existing evaporative useful life requirement of 15 years or 150,00 miles (87 FR at p. 17490). Such alignment reduces certification and database burden.

EPA has requested comment on the appropriate ORVR SHED mixing time for heavy-duty vehicle testing (see 87 FR at pp. 17491 and 17495). Modifications to the mixing time are not required on existing ORVR SHEDs. If existing ORVR SHEDs and/or the rig approach are used, SHED mixing time modifications are not required as the longer fuel-fill events for large fuel tank refills address this concern, where canister emissions must be controlled during the ORVR fill. The graph below presents an example of an ORVR test on a large fuel tank product, where the FID reading is stable within the current mixing time of 60 seconds.



EMA recommends that the vehicle volume used for fuel rig testing should be the same volume used for PZEV rig testing (5 cubic feet as specified in CARB MAC 2001-03, November 2001). Manufacturer testing of large fuel tank fuel rigs indicates that the current mixing time is appropriate, and the 5 cubic feet vehicle volume value as specified in CARB MAC 2001-03 is appropriate for heavy-duty ORVR testing.

EPA's proposal provides that in cases where there is a secondary manufacturer, the ORVR certification and fuel system installation instructions will be controlled by the original OEM (87 FR at pp. 17491-17492). EMA supports the EPA proposal, as it is consistent with current practice related to heavy-duty spitback compliance regulations.

Updates and corrections are required to the proposed evaporative SHED calculations outlined in proposed §86.117-96. EPA's proposed equation in §86.117-96(d) for Methanol mass contains a typographical error. The temperature of the sample withdrawn (TE) is only multiplied by the concentration from the 1st Impinger. TEf and TEi need to move outside of the parenthesis so it applies to the sample from both impingers.

Equation as proposed:

$$M_{CH3OH} = V_n \times \left[\frac{(TE_f \times (C_{MS1f} \times AV_{1f}) + (C_{MS2f} \times AV_{2f}))}{V_{Ef} \times T_{SHEDf}}\right] - \left[\frac{(TE_i \times (C_{MS1i} \times AV_{1i}) + (C_{MS2i} \times AV_{2i}))}{V_{Ei} \times T_{SHEDi}}\right] + (M_{CH3OH,out} - M_{CH3OH,in})$$

Corrected Equation:

$$M_{CH3OH} = V_n \text{ x } \left[\frac{TE_f \text{ x } \left((C_{MS1f} \text{ x } AV_{1f}) + (C_{MS1f} \text{ x } AV_{1f})\right)}{V_{Ef} \text{ x } T_{SHEDf}}\right] - \left[\frac{TE_i \text{ x } \left((C_{MS1i} \text{ x } AV_{1i}) + (C_{MS1i} \text{ x } AV_{1i})\right)}{V_{Ei} \text{ x } T_{SHEDi}}\right] + \left(M_{CH30H,out} - M_{CH30H,in}\right)$$

Additionally, for consistency, EPA should align the Methanol mass equation in §86.143-96(b)(1)(i) with the Methanol mass equation in §86.117 96(d), as proposed in the NPRM.

Also related to the proposed calculations, updates and corrections are required to the SHED evaporative calculations to be consistent with other areas of the CFR and to reflect the latest available standard practices for evaporative calculations. For example, the THC density referenced for the THCE equation in §86.143-96(c) is incorrect. The THC density referenced in §1066.1005(f) is based on a hydrogen-to-carbon ratio of 1.85. As defined 86.143-96(b)(ii), for evaporative emissions, the THC mass assumes a hydrogen to carbon ratio of 2.3. EMA recommends using a density of THC with an H/C ratio of 2.3 in §1066.1005(f), and that EPA update the reference in §86.143-96(c) accordingly.

EMA also has concerns about how the test fuel is specified for ORVR testing. Having a singular test fuel reduces regulatory burden and streamlines the laboratory testing process. The general testing fuel outlined in §1065.710 aligns with the other testing requirements specified in the EPA Tier 3 regulations. Both conventional and flex-fuel vehicles use the same commercial

E10 fuel during refueling. Accordingly, the test fuel specified for both should be the same. EMA recommends that EPA specify that the heavy-duty ORVR test fuel should meet the fuel requirements outlined in §1065.710 for general testing for both conventional and flex-fuel vehicles

Finally, EMA recommends that EPA revise the ORVR fuel-dispensing rate specification. Having a uniform dispensing rate reduces regulatory burden and streamlines the laboratory testing process. Providing for a 9.8 gpm fuel rate would align with the global ORVR fuel-dispensing rate requirements. For fleet customers it is desirable to maximize fill rate (e.g., minimize refueling time) to minimize vehicle down-time. EMA therefore recommends that EPA specify the ORVR fuel dispensing rate as a uniform regulated rate of 9.8 gpm.

With the above recommended modifications to the final rule, EMA believes that the refueling evaporative emissions requirements would be workable and achievable. EMA is ready to work with the Agency on these detailed recommendations.

f. The modifications to SCR inducement strategies should be revised

EPA proposes to codify the SCR inducement strategies (proposed §1036.111) that heretofore have been covered by guidance documents since HDOH SCR technology was first introduced in 2010. EMA supports this proposal, including the proposed new speed-based derate schedule, but suggests EPA consult with NHTSA on the corollary safety aspects. EPA should also allow for transitions between the vehicle speed levels rather than step changes. EMA has the following additional concerns related to certain specific provisions

As an initial matter, the new SCR inducement proposal depends on data recorded using the REAL binning functions required by CARB's OBD regulations. (EPA has proposed to incorporate the obligation to track REAL NO_x emissions in §1036.110.) There are several concerns with how the SCR inducement strategies are tied to the REAL data. First, the SCR inducement is only triggered if a fault is confirmed by the "NO_x override" function described in §1036.111(c). Under that provision, the inducement derate should be overridden if the NO_x conversion efficiency in the 100-Hour Array is within 10% of the NO_x conversion efficiency of the Lifetime Array for REAL Bins 13 and 14. Conversion efficiencies, both lifetime and 100 hour, are going to be calculated based on on-board NO_x sensors. Those sensors, however, are known to have significant inaccuracy, as much as +/- 10 ppm according to manufacturers' specifications in the range of data expected to be recorded in Bins 13 and 14 (the highest engine power level bins). Aged sensors have been known to be significantly less accurate. It is imperative that EPA evaluate the sensitivity of these SCR inducement controls for this purpose. Operation on a very cold day may lead to incorrect inducement determinations based on the NO_x override function. EPA should consider alternative confirmation methods, at least for some fault types, such as loss of DEF pressure at the DEF pump in the case of an empty-DEF tank fault. EMA has more comments regarding the NO_x over-ride factor in Section 8 of these comments.

EMA is willing to work with EPA to determine other similar opportunities. For most of the conditions being evaluated, such as empty DEF tank[18], blocked DEF lines, or missing catalyst, the

[18] The proposed modifications to §1042.660(b) require clarification. EPA should define "non-compliant operation" and "appropriate reductant." The provision should also be clarified as being applicable to "all engines on covered vessels even if the engines are certified to *U.S. EPA* Appendix VI…"

NO_x conversion efficiency should be 0%. A threshold much closer to this value should be applied when inducing for those reasons, in order to account for potential errors.

A second issue of concern is that for certain applications, there may actually be no data in Bins 13 and 14, making the assessment impossible. In addition, EPA proposes that the 100-Hour Array be reset upon confirming that corrective action has been taken (§1036.111(g)). Resetting the Active 100-Hour Array may be in conflict with CARB requirements.

There are additional concerns related to the proposed provisions for deactivating the inducement derates. Under §1036.111(g), the manufacturer must wait for the fault condition to no longer be detected, then reset the 100-Hour Array, and then wait for Bins 13 and 14 to populate with data to confirm NO_x conversion efficiency is restored. That is a long chain of events for the system to be restored, especially for events that may not be related to failure to refill or tampering, such as blocked DEF lines. With respect to empty DEF tank inducements, EPA should allow for the derates to be deactivated as soon as the DEF level sensor indicates a level of refill. If the NO_x override factor does not show adequate conversion (value greater than 10%), the derates could be quickly reactivated at the point where they were deactivated on suspicion of tampering.

In a related matter, EPA has proposed that engines must be compliant with any level of DEF concentration that does not trigger inducement (§1036.115(f)). That would not only mean that the DEF quality sensor ("DQS") must have a detection capability to support this outcome, linked to manufacturers' calibrations and compensation routines, but also that the NO_x override function that CARB requires to confirm the "poor quality" DEF condition prior to triggering inducement must be supportive of the requirement. The role of the NO_x override function is, of course, to confirm compromised emissions *before* triggering inducement. This means that §1036.115(f) and §1036.111(c) are in conflict with one another. As proposed, manufacturers would have to ensure compliance at the same level of emissions that they are confirming to be compromised emissions performance. That is obviously not workable.

Notwithstanding this clear conflict in the proposed requirements, manufacturers have too little experience with the complex future emissions control systems required to meet the proposed very stringent standards to know if compliance can be assured at the urea concentration limits detectable by DQS systems. EPA has made no such demonstration of that capability. The simple fact is that both the industry and EPA are uncertain whether the requirement can be met. EPA should regulate on the basis of data-based evidence, but no such evidence exists regarding this issue. EPA should not include §1036.115(f) in the final rule.

In another related matter, EMA supports the Agency's tank-sizing requirements detailed in §1036.115(i).

g. EMA recommends revisions to the minimum maintenance interval provisions

EPA proposes to modify the emissions-related maintenance provisions, and to establish new requirements related to making information about service-related maintenance available to the vehicle owner. EPA has also updated the minimum maintenance intervals for various components. The proposed maintenance intervals are not aligned with the intervals CARB has finalized in its Omnibus low- NO_x regulations. CARB conducted extensive analysis to understand current industry practices and capabilities, and established the intervals accordingly. EMA recommends that wherever EPA's requirements are more stringent (longer) than CARB's, that they be reduced to align with the CARB requirements. This will ensure that manufacturers have the greatest opportunity to optimize product configurations and maintenance practices based on the latest technical data.

Of particular concern is EPA's proposal to prohibit scheduled maintenance on all sensors at intervals less than today's UL (though the NPRM mentions only NO_x sensors at 87 FR p. 17523). Most sensors, and especially NO_x sensors and most likely NH_3 sensors (where there is little experience), do not have the kind of durability necessary to last throughout the current UL, let alone the new proposed extended UL of the engine. Table 1 of §1036.125 is unclear whether sensors are allowably replaced at current UL (for example, at 435,000 miles for HHDE), as there is no definition of "catalyst systems," and sensors are not always integrated into catalyst systems. Notwithstanding this point, the interval provided is too short for current sensor durability. Manufacturers may be changing their recommended maintenance practices with respect to sensors given the myriad changes in the proposed regulations, including significantly more stringent standards, and longer UL and warranty requirements. EMA recommends that the Agency specify that manufacturers may require scheduled replacement of sensors every 150,000 miles or 4,500 hours for HHDE and MHDE, and every 100,00 miles or 3,000 hours for LHDE and SI engines, just as permitted under the CARB Omnibus regulations.

Another example is for EGR system cleaning, where CARB retained previous minimum cleaning intervals of 100,000 mi/3,000 hours of use initially, and specified 150,000 mi/4,500 hour intervals thereafter (MHDE and HHDE.) EPA should retain the initial shorter period for MHDE and HHDE before changing to the longer interval for subsequent maintenance events.

Other aspects of the Agency's proposed maintenance requirements are problematic as well. As an initial matter, it is unreasonable to require manufacturers to prominently "advertise" to vehicle-owners their right to have emissions-related repairs performed at non-affiliated independent repair facilities using third-party components of the owners choosing. Manufacturers have invested billions of dollars developing products that are compliant with the Agency's ever-increasingly stringent emissions standards. Putting the entirety of that effort, at huge customer and societal expense, at risk by prominently highlighting this "right-to-repair" appears to be at odds with ensuring the feasibility and durability of the new low-NO_x controls and systems that the Agency is seeking to mandate. On top of that, it is discouraging that EPA is willing to compel this type of advocacy for independent repair facilities, directly in competition with the companies who have made these significant investments, time and time again, in response to the Agency's latest emissions standards and diagnostic requirements. While the CAA does not permit manufacturers to require repairs at their own facilities as a condition to honor emissions warranties, it does not require manufacturers to actively encourage owners to seek repair elsewhere from independent repair facilities, or to use third-party components, putting emissions compliance at risk.

While EPA may permit an engine manufacturer to void an in-use test (or reject a candidate vehicle) if an aftermarket DPF or other third-party components are used, there are no such guarantees available to manufacturers when utilizing some of the alternative compliance demonstration methods. For example, among the DF verification procedures a manufacturer may use is one which involves submitting NO_x sensor-based emissions results from a high volume of vehicles (50% of the family volume) in operation. Similarly, the in-use testing provisions at §1036.405(g) permit manufacturers to use on-board NO_x sensor data as a surrogate for PEMS-based testing as a means to satisfy an in-use test order (the volume requirements are not specified, but EPA may similarly require a high volume of vehicles to use this provision). In both of those cases, it is impossible for the manufacturer to inspect each vehicle to confirm that there are only manufacturer-approved components, or to review vehicle records to confirm that independent repair facilities have not (mis)performed maintenance or repairs. In fact, there is no obvious way for a manufacturer even to investigate those matters, as the affiliated dealers would not possess such records. In this regard, it is impossible for a manufacturer to adequately screen to exclude such vehicles from consideration. In the final rule, EPA should eliminate the requirement to make the independent repair and third-party component statements as proposed.

If EPA chooses not to delete the requirements of §1036.125(f), EPA has allowed the provision to be disregarded only under one of two conditions. The first condition is that the manufacturer commits in the purchase agreement to provide components or services free of charge. While it is not clear whether this is with respect only to any isolated, named components or services, or to all components or services, the requirement is nonetheless unreasonable. The second condition is to demonstrate to the Agency that the "engine" will work properly with the "identified" component or service. This would mean that the manufacturer would have to be aware of *all* possible sources for the service or components, and to have explicit knowledge about *all* the services or components and their potential impact to emissions, which is impossible, and therefore unworkable.

The provisions of §1036.125(g) allow manufacturers to pay for emissions-related maintenance under various circumstances. The sentence reads, "You must pay for scheduled maintenance on any component during the useful life if it meets…" That statement, as written, is overly broad. It should read, "You must pay for scheduled maintenance *not otherwise allowed by this section* on any component during the useful life if it meets…" Similarly, EMA recommends that §1036.125(a)(2) be modified to read, "You may not schedule replacement of catalyst beds or particulate filters during an engine's useful life*, except as allowed in paragraph (g).*" Finally, EPA should include definitions of "particulate filtration system," "particulate filter," "Catalyst system," and "catalyst bed" to clarify the distinctions being made in Table 1 of §1036.125.

EPA's maintenance-related requirements go on to require additional information to be included in the owner's manual. Under §1036.125(h)(2), manufacturers must "identify steps owners must take to qualify their engines as properly maintained, consistent with the requirements of this section." The owner's manual must also instruct owners as to what "documentation you [the manufacturer] consider appropriate for making these demonstrations." These requirements are not practical. First, there's an implication that owners are "on notice" as to documentation responsibilities, and are somehow responsible to maintain emissions-related maintenance records. Second, it makes no sense for the manufacturer, speaking through the owner's manual, to advise what should be done to "qualify" their engines as "properly maintained." Not only is it totally foreign to customers to "qualify" their purchased products in any way, but there would be an underlying sentiment that overlooking other maintenance requirements might nonetheless still provide for a vehicle that is "properly maintained." The whole of §1036.125(h)(2) is inappropriate and unreasonable on its face, and should be removed from the final rule.

EMA opposes the proposed requirement to describe the emissions control system and OBD trouble codes (§§1036.125(h)(4) through (8)) in such detail as to give owners the sense that they could apply "backyard mechanic" skills to repair complex emissions control systems, despite a complete lack of training, and without the correct tools to make quality repairs to restore emissions control. Just the opposite could happen, where the actions of the owner could lead to other component issues and potentially more severe emissions exceedances. Today's technicians connect to the emissions control system with qualified tools to perform diagnostic routes, and to reset parameters when new sensors are installed. This level of rigor is required to take appropriate corrective action on today's complex emissions control systems.

EPA should abandon the proposal to compel manufacturers to educate owners on repair processes through the owner's manual. The proposed requirements of §§1036.125(h)(3) through (11) should be deleted in the final rule. Current service information requirements offer qualified repair technicians the tools, information and supporting training they need to effect quality repairs. This should be the preferred path owners take when they are alerted to component issues by way of the OBD MIL lamp.

h. EPA should not expand the scope of components to be included as emissions-related components

The proposed warranty provisions under §1036.120(c) require that, "The emission-related warranty covers all components whose failure would increase an engine's emissions of any regulated pollutant, including components listed in 40 CFR part 1068, appendix A, and components from any other system you develop to control emissions." That proposed expansion of warranty is overly broad. Current provisions allow that an emissions-related components' is one that has a "primary purpose to reduce emissions or whose failure would commonly increase emissions without significantly degrading engine/equipment performance." (See item IV in the referenced Part 1068 Appendix I, and definition of Critical Emissions-Related Component proposed in §1068.30.) EPA should not expand the universe of components to be covered under the emissions warranty provisions to include those components whose only relation to emissions control is that a failure would increase emissions. EMA agrees with EPA's assessment that, "the cost of expanding the list of warrantable components to include all components that may trigger an OBD MIL, regardless of their direct impact on emissions, would be unreasonable." (87 FR at p. 17509) EMA recommends that this aspect of §1036.120(c) be eliminated in the final rule.

Also of concern is the proposed requirement under §1036.120(b) that the emissions-related warranty should not be shorter in duration than any published warranty a manufacturer "offers with or without charge." EMA believes the use of the word "offers" could be misleading, as it does not directly reflect the warranty actually *provided* as part of a vehicle sale, whether with or without charge. EPA should clarify this language.

i. Recommendations related to labeling provisions

EMA has concerns related to the proposed QR code included in the labeling requirements of §1036.135(c)(10). EMA is generally supportive of the concept of electronic labeling, and has been working to develop specific features of electronic labeling for some time. We do, however, have concerns about the QR code requirements EPA proposes.

As an initial matter, EMA views electronic labeling as an alternative to conventional emissions label requirements. EPA's proposal, however, is to add a QR code to the existing emissions label. EPA should make the QR code-based label available as an alternative to the existing physical label mounted on the engine.

If EPA does not finalize the rule with the option to use electronic labeling as an alternative to conventional labeling requirements, EMA recommends that manufacturers be given the option to add a second label featuring the QR code EPA describes, as an alternative to adding the QR code to the existing label. A manufacturer should also be given the option to make a readable QR code accessible by means other than labeling. For instance, the QR code could be readable as a physical impression on a component surface accessible to users.

EMA does not think it is appropriate that owner's manuals be accessible from the QR code required. Manufacturers already have various means to make owner's manuals available to users. To make them available via the QR code is redundant and unnecessary. This requirement should be eliminated in the final rule.

The other information proposed to be accessible through the QR code link requires clarification. For example, it is unclear what EPA means in §1036.135(c)(10)(i) by, "as long as the appropriate information is available for each engine." It is unclear what "appropriate" information is intended to be covered, and how it must be associated with the engine from which the QR code was read. In (ii), it is unclear if EPA is requiring the same list of emissions control systems that manufacturers are required to include on the emissions control label. If that is the case, EMA recommends removing that redundant requirement. In (iii), EMA is uncertain what type of fuel and lubricants requirements EPA is proposing to include. It is also a risk to exclude fuel sulfur level requirements when providing fuel requirements; that element of the provision should be removed in the final rule. EMA stands ready to work with the Agency to finalize §1036.135 in a more reasonable manner.

EMA recommends that EPA make available an option that EPA host the QR-code accessed information proposed under §1036.135(c)(10) on an EPA-supported website. Although individual manufacturers could host this information, it would be preferrable for some users accessing this information for EPA to do so. EPA could design a website, similar to Fueleconomy.gov, which would provide data to the public in a consistent format for all engine manufacturers.

j. The proposed adjustable parameter provisions should be improved

EPA has proposed to transition the "adjustable parameters" provisions to §1068.50, including numerous amendments. EMA supports the consolidation of these requirements, and finds most of the proposed requirements to be reasonable and practical. EMA recommends several modifications, however, to address various concerns.

EPA's proposal to migrate, consolidate, and revise adjustable parameter provisions in a new proposed section 1068.50, would apply broadly to on- and off-highway engine categories starting in MY 2024. Among the updates are proposed provisions regarding the adjustability of electronically controlled parameters, which manufacturers must limit through ECM password or encryption protection. In that regard, if EPA learns that the new provisions drive significant ECM changes such as hardware upgrades, EPA should provide additional lead time to implement the changes at least for some applications. For example, it may not be possible to upgrade ECMs for certain spark-ignited alternative fuel and off-highway families until MY 2027. EPA should allow additional lead time, especially for lower volume and/or non-SCR engines such as in these categories.

More generally, the proposed adjustable parameters provisions should be streamlined for improved understanding and greater consistency. There are three main ways in which this could be accomplished. First, the provisions could be restructured to define basic concepts, then to break down how they apply to physically adjustable parameters, programmable adjustable parameters, and replenishable parameters. Second, it is not necessary to define "operating parameters" to achieve EPA's goals in these provisions. Finally, it is recommended to apply greater consistency in terminology. We will discuss these points in detail, and make other recommendations as well.

EMA recommends restructuring the proposed §1068.50 to improve clarity and consistency in the application of the fundamental principles of EPA's adjustable parameter controls. The provisions should start with the most fundamental principle that emissions compliance is required, consistent with the standard setting part, over the range of adjustments to which the user has access. "Adjustable parameter" should then be defined, including the specific requirements regarding the "practical" range of adjustment with respect to the three types of adjustable parameters of relevance: physically adjustable parameters, programmable parameters and user-replenishable consumables. For each of those three types of adjustable parameters, EPA should set forth the requirements and limitations that EPA considers appropriate for the practical range of adjustment.

Consistent with the recommendation of the previous paragraph, §1068.50(a) should be modified. The provision as proposed, which states:

> The standard-setting part generally requires that production engines, pre-production engines, and in-use engines with adjustable parameters meet all the requirements of this part for any adjustment in the physically adjustable range.

should be modified to read:

> The standard-setting part generally requires that, as a condition of certification, engines with adjustable parameters meet all the requirements of the standard-setting part for any adjustment in the practically adjustable range.

Related to the improved structure recommended above, the new provisions could be simplified by eliminating the definition of "operating parameter." It is adequate, clearer and more efficient to simply define an "adjustable parameter," including the special condition of the practical range of adjustment, and the consequence of emissions increases. EPA should not finalize requirements that could be interpreted as requiring manufacturers to disclose all "operating parameters," because on most modern engines there are thousands of programmable parameters coded into the ECUs. For example, §§§1036.205(r) and §1039.205(s) require that manufacturers "Describe all adjustable operating parameters (<u>see</u> §1036.115(f)), including production tolerances.

For any operating parameters that do not qualify as adjustable parameters, include a description supporting your conclusion.” The manufacturer’s responsibility should be to disclose all parameters to which users have practical access for adjustment. Descriptions of how manufacturers will limit access to ECU code through passwords and encryption can be managed without the complexity EPA included in the proposed definition of “operating parameter.”

EPA includes the following in §1068.50(c)(1): “An operating parameter is not an adjustable parameter if…we determine that engine operation over the full range of adjustment does not affect emissions without also degrading engine performance to the extent that operators will be aware of the problem.” However, §86.094-22(e)(ii) provides that, “The Administrator may, in addition, determine to be subject to adjustment any other parameters on any vehicle or engine which is physically capable of being adjusted and which may *significantly* affect emissions.” (Emphasis added.) The requirement that emissions impacts from adjustable parameters should be significant as a condition for adjustment limitation requirements is an important consideration, as adjustments should not be encumbered with regulated adjustment limitations and related obligations when the emissions impacts are minor. The final provisions should not exclude the “significant” qualifier when addressing emissions impacts related to adjustable parameters.

Regarding terminology, the term “physically adjustable parameter” should be used in lieu of “mechanically controlled parameter,” and “programmable parameter“ in lieu of “electronically controlled parameter” and “electronically controlled setting.” In addition, §1068.50(c)(2)(ii) and (iii) should not be limited to “mechanically controlled engines.”

The proposed regulations require further consolidation related to adjustable parameters to eliminate confusion as to definitions and applicability. For example, the definition of “Adjustable Parameter” in §1039.801 should be replaced with a reference to the proposed §1068.50. Additionally, §1036.250(r) and §1039.205(s) include further descriptive elements related to adjustable parameters, including requirements to provide in the application for certification “*nominal or recommended setting*, the *intended physically adjustable range*, and the limits or stops used to establish *adjustable ranges*. Also include information showing why the limits, stops, or other means of *inhibiting adjustment* are effective in *preventing adjustment* of parameters on in-use engines to settings outside your *intended physically adjustable range*.” (Emphasis added.) While perhaps reasonably descriptive, the various terms used may cause confusion when referencing §1068.50. EMA stands ready to work with the Agency on improving the consistency and clarity of the various CFR provisions related to adjustable parameters. While we have made reference in these comments to the adjustable parameter provisions in Parts 1036 and 1037, our comments should be applied more generally to other sections where adjustable parameters are included, such as Part 1042. Additionally, §86.094-22 may require modification to terminate its applicability at the appropriate model year.

Many states are adopting “right to repair” legislation or regulations that compel manufacturers to make service tools and instructions available to third-party independent repair facilities. Those regulations usually require that manufacturers allow the independent repair centers to gain access to programmability normally protected from anyone outside the OEM’s dealer network, including granting the ability to reflash ECUs with different ratings. EMA opposes those right-to-repair laws and regulations because, among other concerns, they could lead to problems where engines and vehicles are not in their certified configuration, or, even, worse, they open the door for nefarious actions violative of EPA's tampering prohibitions. Notwithstanding EMA's opposition, right-to-repair regulations are becoming more and more prevalent each year. Engine manufacturers cannot be held liable for the actions of the independent repair facilities. It is important for EPA to acknowledge this by providing appropriate protections in the adjustable parameter provisions. To that end, EMA recommends that EPA add the italicized text to §1068.50(d)(2):

> Conversely, such parameters are not practically adjustable if you limit access to the electronic control units with password or encryption protection. You must have adequate protections in place to prevent distribution and use of passwords or encryption keys, *except where required by law to make them available.* We may exclude…

In addition to EMA's concerns related to right-to-repair laws, there are also concerns about the adjustable parameter provisions as they relate to enterprises unlawfully marketing emissions "delete" kits that employ various techniques, through programming or hardware changes or both, to tamper with emissions control systems. While engine manufacturers take significant steps to try to prevent those actors from "hacking" into the ECU to reprogram controls or to override tampering detection capabilities, it is impossible to completely protect engine systems from such actions. We therefore recommend that §1068.50(f)(3) be modified as follows:

> If your engines/equipment have other electronic [*programmable*] settings that can be *legally* modified or accessed as described in paragraph (d)(2) of this section, consider all those settings to be within the practically adjustable range.

Similarly, §1068.50(d)(1) should be modified to say:

> …Any such items that are *legally* sold at hardware stores, automotive parts supply stores or on the Internet are considered available.

As well, (d)(2) should be modified to say:

> Electronically controlled parameters are considered "practically adjustable" if they can be adjusted using any *legally* available tools (including devices that are used to alter computer code).

These recommended amendments to the proposal are important to avoid undue manufacturer liability as it relates to certain tampering actions.

EMA also recommends a specific change to the adjustable parameters provisions applicable to small SI engines ("SSIE"). In proposed §1054.115(b), after the reference to §1068.50, the following language should be added:

> However, engine speed control (insert rabbit turtle symbol) and governor (insert paperclip symbol) levers on engines regulated under Part 1054 are not considered to be adjustable parameters as defined in §1068.50.

Due to the inherent design of SSIEs, it is inappropriate to include the engine speed control and governor levers as adjustable parameters. EMA provided extensive background information to the EPA Gasoline Engine Compliance Center, Compliance Division on August 24, 2020, in a follow up discussion after the issuance of the May 11, 2020, Test Cycle Guidance Document. The presentation appended as **Exhibit "F"** to these comments was used to demonstrate the operation and function of speed controls and governor levers, and explained why it is inappropriate for them to be considered adjustable parameters. We believe EPA staff understood and agreed with EMA's position based on subsequent discussions.

In addition, in proposed §1054.230(b)(8) an example is included to provide additional guidance to manufacturers. While this example is helpful, EMA recommends that the provision clearly state that in cases where an engine manufacturer sources a component from multiple suppliers, those components being made to the same specifications, the engines produced from those components may be included in the same engine family.

From a broader viewpoint, EPA is proposing that the consolidated and modernized adjustable parameter provisions of §1068.50, applying to on- and off-highway engine categories, would be effective starting MY 2024. Among the updates proposed are provisions regarding the adjustability of electronically controlled parameters, which manufacturers must limit through ECM password or encryption protection. As noted, if the new provisions compel significant ECM changes, such as hardware upgrades, EPA should provide additional lead time to implement the changes, at least for some applications. For example, it may not be possible to upgrade ECMs for certain spark-ignited alternative fuel or off-highway families until MY 2027. EPA should allow additional lead time for such engines, especially for lower volume and/or non-SCR applications.

Finally, EPA should review all guidance documents related to adjustable parameters and update them as appropriate to be consistent with the revised adjustable parameter provisions. EMA stands ready to support the Agency in this effort.

k. EPA's design requirement regarding ease of emissions sampling is unwarranted

EPA proposes in §1036.205(t) to include a design requirement that engine manufacturers would have to include in their installation instructions to a vehicle manufacturer (§1036.130) that would facilitate in-use testing. More specifically, the engine manufacturer would be required in those instructions to "specify how to ensure that sampling of exhaust emissions will be possible after engines are installed in equipment and placed in service. If this cannot be done by simply adding a 20-centimeter extension to the exhaust pipe, show how to sample exhaust emissions in a way that prevents diluting the exhaust sample with ambient air."

As an initial matter, imposing requirements on the vehicle design that go beyond those required to ensure compliance, and that instead are imposed solely to enable the rare instances that someone would want to conduct PEMS testing on a vehicle, is an unnecessary and unwarranted requirement. Compelling less than optimal designs, that could take precedence over practical installation considerations and limitations, and potentially impose higher costs, is unreasonable solely to make exhaust sampling easier than it otherwise might be

EMA recommends that the provisions regarding installation instructions at §1036.130 be finalized to include a "recommended practice" with respect to vehicle design, to be followed "whenever practical." Those instructions should recommend physical characteristics of the installed design, without reference to extension dimensions or ambient air dilution, which would not be meaningful to the vehicle design and installation personnel. The resulting design recommendations should be established in a way that would facilitate PEMS testing. EMA further recommends that EPA simplify the proposed §1036.205(t) accordingly, referencing §1036.130. Finally, both provisions should refer to installation instructions, since they concern vehicles rather than equipment.

l. The exemptions related to U.S. territories should be revised

EPA proposes to remove the exemption for aftertreatment-equipped engines sold into Guam because USLDF is now widely available in that territory (§1036.655). EMA supports the proposal, but manufacturers will need more time to plan for this change and to modify emissions labels accordingly. To simplify planning of product supply and delivery, EMA recommends that EPA implement this change to be effective at the start of a new calendar year. Given the anticipated timing of the CTP rulemaking, EMA recommends that the exemption become effective on January 1, 2023.

Also related to the ULSDF exemption, EPA has proposed to limit the exclusion for non-road engines in the territories of American Samoa and the Commonwealth of the Northern Mariana Islands to engines "at or above 56kW" (§1039.655). Many manufacturers' products below 56kW use DPFs to control PM emissions. Those engines require ULSDF to ensure long-term emissions control. EPA should not limit the exemption to engines at or above 56kW.

14. <u>EMA's Recommendations for Reasonable Flexibilities and Constraints in the NO_x ABT Program and FEL Caps</u>

a. EMA's views regarding ABT

A successful heavy-duty engine emissions regulation necessarily includes an Averaging, Banking and Trading ("ABT") program with the appropriate balance of flexibilities and constraints, coupled with an appropriate engine Family Emission Limit ("FEL") cap. Such an ABT program provides manufacturers with the needed flexibility to plan investments and manage product costs while also providing opportunities to overcome technical or lead-time challenges. Those attributes of ABT all help manufacturers deliver reliable and affordable products that meet the diverse range of heavy-duty applications and customer needs.

For these reasons, EMA generally supports EPA's proposed ABT program, which provides environmental benefits and the flexibility manufacturers require to address customer needs. However, because of the uncertainty associated with market adoption of zero and near-zero NO_x emissions technologies, EMA recommends that EPA modify the proposal to include certain constraints to prevent unintended consequences from the ABT program. For example, a relatively unconstrained ABT program could lead to competitive imbalances among manufacturers, especially where product mix differences exist. More specifically, if zero-NO_x emissions technologies sold in one market subsegment are used to bank significant NO_x credits, those could be used to offer higher-emitting, lower-cost engines in a different market subsegment, competing against another manufacturer without credits and that, as a result, is only able to offer lower-emitting, higher-cost engines. That would disrupt the current competitively level playing field in that subsegment of the market, and could discourage the purchase of lower-emitting engines.

To prevent such an unintended outcome, EPA should maintain its current NO_x ABT averaging set categories based on primary intended service classes (i.e., HDE SI, LHDE CI, MHD CI, and HHD CI). To include zero-emissions powertrains (that are neither spark-ignited nor compression-ignited internal combustion engine-based) in the ABT program, EPA should prescribe how to align its vehicle-level primary intended service classes from EPA's Heavy-Duty GHG Phase 2 regulations in 40 CFR Part 1037 with the appropriate engine-based NO_x averaging set.

To further prevent unintended consequences, EPA should reduce the FTP/RMC NO_x FEL cap to be no higher than 0.100 g/bhp-hr for all service classes. Setting that lower FEL cap also will help to mitigate the competitive problems described above. With those averaging set and FEL cap provisions in place to protect against unintended consequences, EMA recommends that EPA allow unlimited NO_x credit life, in lieu of the Agency's proposed 5-year credit life.

EPA also has requested comment on a 5% annual sales flexibility to address specialty vehicle applications. In that regard, EMA recommends a low-volume "legacy engine" flexibility provision that a manufacturer could utilize for the most challenging applications. Specifically, EMA recommends that the final rule provide that a manufacturer may sell US10-compliant engines in volumes up to 5% of their total annual sales volume in the same primary intended service class for a period of 3 years. EMA recommends further limiting this flexibility provision to include only engines that have low annual average miles traveled, thereby minimizing the emissions inventory consequences of this flexibility allowance. This can be achieved by allowing legacy engine sales only from the following engine and vehicle applications: 1) ≥525 hp engine family sales into any vehicle application; and 2) any engine sales that are directed for installation in the following 40 CFR Part 1037 vehicle categories: heavy-haul tractors, custom chassis motor homes, concrete mixers, and emergency vehicles. All of those engine and vehicle categories have very low average annual vehicle miles traveled. EMA also supports EPA's proposal to allow for limited sales of previous-Tier engines according to the limitations as described.

b. Additional concerns with ZEV ABT requirements

In medium- and heavy-duty applications, BEVs and FCVs can be used in emissions-reducing applications that do not accumulate mileage. For instance, a vehicle may be used as a source of electricity in remote applications, or at a job site, replacing a generator and powering jobsite equipment. A zero-emission vehicle may be used to temporarily power a building, replacing a generator. In advanced applications, a vehicle or a fleet of vehicles may be used to supplement electricity grid services, such as through load-leveling. These example applications have the potential to create societal value using advanced transportation technologies to reduce emissions traditionally associated with other sectors. NESCAUM[19], Union of Concerned Scientists (UCS)[20], Environmental Defense Fund (EDF)[21], International Council on Clean Transportation (ICCT)[22], Rocky Mountain Institute (RMI)[23], Sierra Club[24], the State of California, and the United States Department of Energy[25] have all recognized the potential value from zero-emissions vehicles, and especially from medium-duty and-heavy duty zero emissions vehicles, through their deployment in innovative applications.

CARB, EPA, and the United Nations are all proposing regulations requiring manufacturers to report on or meet battery durability, UL, and warranty requirements, as measured by different test and certification procedures. Those multiple requirements are duplicative, and burdensome, and possibly counter-productive to accelerating the deployment of zero-emissions vehicles, and the realization of the attendant emissions reductions. CARB is proposing to regulate battery durability through Advanced Clean Cars II[26]; EPA has proposed new test procedures for energy storage devices in this NPRM[27]; and the United Nations Economic Commission for Europe

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[19] "Providing V2G services benefits school districts and utility ratepayers by generating revenue that improves the economics of fleet electrification while reducing electricity distribution system costs for ratepayers." (page 15-16, pages 31-35), Multi-State Medium- and Heavy-duty Zero-Emission Vehicle Action Plan. https://www.nescaum.org/documents/mhd-zev-action-plan-public-draft-03-10-2022.pdf/

[20] "Flexible loads and V2G can provide many of the same benefits as dedicated storage, such as enabling increased market penetration by renewables." (page 4), Charging Smart. https://www.ucsusa.org/sites/default/files/attach/2017/05/Charging-Smart-executive-summary.pdf

[21] EDF supported research through the *NC Clean Energy Technology Center (NCCETC)* in coordination with *Roanoke Electric Cooperative (REC)* to demonstrate vehicle-to-grid smart chargers. "Preliminary findings from a demonstration of two-way, vehicle-to-grid (V2G) technology in North Carolina show the economic potential for using bidirectional charging technologies to feed energy stored in electric vehicle batteries back to charging sites, especially when the grid is experiencing high demand.", NC Cooperative Demonstration of Vehicle-to-Grid Smart Charger Shows Economic Value. https://nccleantech.ncsu.edu/2021/09/21/nc-cooperative-demonstration-of-vehicle-to-grid-smart-charger-shows-economic-value/

[22] "EVs could potentially benefit the grid through additional services that help utilities manage load. For example, an EV that is plugged in all day could be used to store excess electricity during off-peak hours; he utility could later withdraw that electricity from the EV battery to supply peak load, avoiding some inefficient cycling of generators." ICCT recommends that policy makers "Create or amend rules to allow participation by EVs in electricity markets, so EVs can provide and be compensated for ancillary services." (pages 3-4), Electric Vehicle Grid Integration in the U.S., Europe, and China. https://theicct.org/wp-content/uploads/2021/06/ICCT_Briefing_EV-grid_integration_20130923.pdf

[23] "Actions on the demand side, such as improved energy efficiency (and appliance efficiency), demand response, community scale RE and battery storage systems, vehicle-grid systems, etc. can benefit the system by smoothening peak loads, mitigating grid power shortfalls, and sustaining critical services during power outages." (page 19) Powering Through: A Climate Resilient Future. https://rmi.org/insight/powering-through-a-climate-resilient-future/

[24] "Vehicle-to-grid (V2G) technology allows EVs to absorb electricity from the grid when it's plentiful, and then provide electricity back to the grid when – and where – it's needed most. Heavy-duty electric vehicle fleets are particularly attractive energy resources." Electric Vehicles are Indispensable for California's Climate Resiliency, Even During a Power Outage. https://www.sierraclub.org/articles/2020/09/electric-vehicles-are-indispensable-for-californias-climate-resiliency-even-during

[25] "The current availability of plug-in electric vehicles (PEVs), and their projected penetration of the private transportation market in the coming years, introduces the possibility of feeding the energy stored in the vehicle batteries back to the electric grid." (page 1), Vehicle-to-Grid (V2G) Power Flow Regulations and Building Codes Review by the AVTA. https://www.energy.gov/sites/prod/files/2014/02/f8/v2g_power_flow_rpt.pdf

[26] Advanced Clean Cars 2, Proposed Regulation Order. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/accii/appa8.pdf

[27] § 1037.552 Multicycle powertrain test for battery electric vehicles. (Pages 310 – 319.) https://www.epa.gov/system/files/documents/2022-03/hd2027-nprm-reg-redline-memo-2020-02.pdf

has finalized a Global Technical Requirement (UN GTR) for light-duty vehicle battery durability[28] (Heavy-Duty in-vehicle battery durability development was started in 2022). EPA should work with those regulating bodies to coalesce around a single harmonized standard. The UN GTR process has incorporated feedback from manufacturers, more so than the CARB or EPA rulemakings. The Society of Automotive Engineers J1979 and J1939 standards may be excellent references as the topic matures as well. Complying with multiple regulations, having different requirements and test procedures, has the potential to slow manufacturers' ability to bring zero-emissions vehicles into the market and could prevent the realization of economies of scale. As with any emerging market, regulations can have unintended consequences. For example, mileage-based warranties and ULs could preclude zero-emission vehicles from participating in innovative applications, such as electricity grid services.

15. EPA Has Not Fully Considered the Impacts of Fuel Quality and Lubricants Issues

EMA is evaluating the role that low-carbon fuels can play to reduce GHG emissions impacts from the multiple engine product sectors. Low-carbon fuels provide the opportunity to effect very significant near-term CO_2 reductions because, to the extent that they are available as "drop-in" fuels, they can improve emissions from existing fleets without the need for additional technological advancements or the time for market adoption and phase-in. This opportunity can be scaled quickly, limited only by the fuel supply and the fuels' compatibility with the engine and aftertreatment systems in which they would be used. EMA is very interested in the potential for the widespread use of low carbon fuels. Steps will have to be taken, however, to improve and enforce the quality of those fuels to ensure market success.

a. Fuel standards should be tightened

EPA's proposed procedures for in-use testing require that MY 2027 and later products comply with all in-use standards when operating on "any commercially available biodiesel fuel blend that meets the specifications for ASTM D975 or ASTM D7467." (See §1036.415(c)(1).) There is a significant body of evidence accumulated over the last decade[29] showing that fuel quality has a significant impact on emissions. Poor fuel quality, especially driven by the biodiesel chemistry, production processes, and distribution impacts, is prevalent in the U.S. compared to the rest of the leading markets (USMCA, EU, Japan). This is driven to a large extent by inadequate fuel quality standards as published by ASTM compared to other world-wide standards. Those inadequate standards and associated lack of regulatory oversight have led to vehicle downtime, and risks of elevated in-use emissions. Those risks will be even greater for engines and vehicles compliant with the proposed low-NO_x emissions standards, where a single tank of poor-quality biodiesel fuel can permanently compromise the emission reduction efficacy of the entire aftertreatment system. The effect of this is shown in the CARB LED study.

[28] Final Light-Duty UN GTR #22 for In-Vehicle Battery Durability. https://unece.org/transport/documents/2022/04/standards/un-gtr-no22-vehicle-battery-durability-electrified-vehicles

[29] CARB Low Emission Diesel Study (LED): Low Emission Diesel (LED) Study: Biodiesel and Renewable Diesel Emissions in Legacy and New Technology Diesel Engines - Final Report (ca.gov)

Furthermore, the recently published Fuels Institute's Diesel Fuel Quality Council's (DFQC) field fuel quality study[30] revealed that over 50% of nozzle samples contained metals such as magnesium, calcium, and zinc, which are all elements poisonous to the aftertreatment system. While those metals values were within the ASTM standard, several manufacturers expressed concern that even at low levels, those metals could be impactful to aftertreatment deterioration at higher mileages. Those results, combined with the fact that 32% of the samples failed to meet the 20-hour oxidation stability threshold, raise serious concerns about the potential impacts of fuel quality going forward as new low-NO_x requirements take effect. Finally, it is known that regular preventative tank maintenance can aid in minimizing unfavorable fuel properties such as high oxidation stability and high metal contamination. The DFQC field fuel quality study reported that less than 22% of tank sites reported performing routine tank maintenance.

Biodiesel also can degrade some gaskets and seals with prolonged exposure, particularly those made from natural or nitrile rubber. The lack of oxidation stability of biodiesel can put materials at risk of swelling, leaking, and/or failure. Fuel lines containing elements such as brass, bronze, copper, lead, tin, and zinc, may accelerate the oxidation process of biodiesel, thereby creating fuel insoluble compounds or gels and salts.

b. Metal contamination is detrimental for aftertreatment performance

As acknowledged by EPA in the Draft RIA, metallic contamination in the aftertreatment due to fuel-borne contaminants has been shown in a variety of studies to degrade emissions control catalysts. "*Brookshear et al. 2012 studied the impact of Na on heavy-duty diesel engine aftertreatment devices. In this accelerated aging study, they doped a B20 fuel to 5,000 ppm each of Na and S and aged to an equivalent 435,000 miles. They found impacts on SCR function if the SCR was positioned before the DPF*." Due to the cold-start stringency proposed, leading concepts for system layouts, including EPA's Low-NO_x Stage 3 demonstration system at SWRI, rely heavily on an SCR placed before the DPF. EPA further acknowledges these concerns, as follows:

"*Williams et al. 2013 studied the effect of Na, K and Ca on a 2011 LD 6.7L diesel engine aftertreatment. They doped their B20 fuel to 14 times the pseudo 1 ppm Na and Ca limit of a B20 fuel and accelerated aged the emission control systems out to 150,000 miles. The authors aged sets of production exhaust systems that included a DOC, SCR catalyst, and DPF. Four separate exhaust systems were aged, each with a different fuel: ULSD containing no measurable metals, B20 containing sodium, B20 containing potassium, and B20 containing calcium. Analysis of the aged catalysts included Federal Test Procedure emissions testing with the systems installed on a Ford F250 pickup, bench flow reactor testing of catalyst cores, and electron probe microanalysis (EPMA). The thermo-mechanical properties of the aged DPFs were also measured.*

EPMA imaging of aged catalyst parts found that both the Na and K penetrated into the washcoat of the DOC and SCR catalysts, while Ca remained on the surface of the washcoat. Bench flow reactor experiments were used to measure the standard NO_x conversion, NH_3 storage, and NH_3 oxidation for each of the aged SCR catalysts. Flow reactor results showed that the first inch of the SCR catalysts exposed to Na and K had reduced NO_x conversion through a range of

[30] Fuel Institute [Diesel Fuel Sampling Study: An Evaluation of Diesel Fuel Sold and Consumed in the U.S. Market | Fuels Institute]

temperatures (Figure 1-8 and Figure 1-9) and also had reduced NH_3 storage capacity. The SCR catalyst exposed to Ca had similar NO_x conversion and NH_3 storage performance compared to the catalyst aged with ULSD."

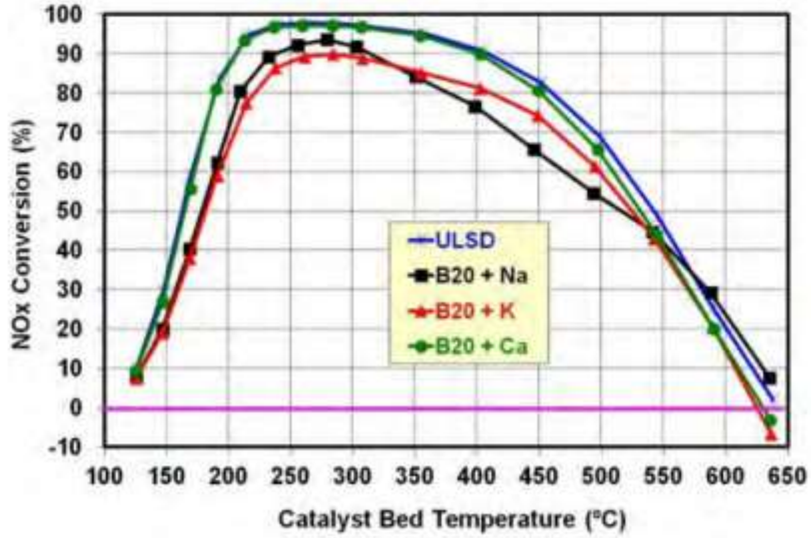


Figure 1-8: SCR NO_X conversion for the first inch of aged SCR catalysts.[54]

EPA has also referenced "*A level of 1 mg/kg (1 part per million) of trace metal in the fuel result in an estimated accumulation of about 22 g of trace metal in diesel particulate filters per 100,000 miles (assuming a fuel economy of 15 mpg and 100% trapping efficiency)*." Even at that low concentration, this equates to an additional 132 grams of DPF ash in a 600,000 mile full useful life. The additional ash accumulation caused by low levels of metals in the fuel will require more frequent DPF ash maintenance.

EPA suggests manufacturers can overcome this challenge by simply increasing the size of their emissions control catalysts, but fails to recognize that while a 5% conversion loss due to metallic contamination may have been acceptable with a 0.2 g/hp-hr standard, it is not acceptable with a 0.02 g/hp-hr standard, or even a 0.05 g/hp-hr standard. Increasing catalyst size also increases the thermal inertia of the system, which is counterproductive to the rapid catalyst light-off required by these regulations. Finally, increasing catalyst size adds additional cost to the product and requires additional installation space in the vehicle, potentially driving additional complexity around aftertreatment variants in vehicle applications.

In addition, metals are technically unregulated in ASTM D975 and ASTM D7467, which does not clearly translate to a design criteria. Since EPA's data shows metallic contamination is low, EMA recommends EPA work with ASTM to adopt lower limits, in the range of 1ppm, for all metals, and particularly phosphorous, sodium and potassium, in all finished fuel blends. With regard to ASTM D6751, EMA strongly recommends a reduction to the phosphorous limit from 10ppm to something in the range of 1ppm. Individually, these contaminants at concentrations >1ppm can have irreversible impacts on aftertreatment elements.

Engine manufacturers develop products to meet a range of emissions, safety and performance requirements driven by customer demand and regulatory requirements.

Manufacturers believe that the availability of biodiesel fuels presents a significant risk to compliance with emissions standards and to customers' satisfaction. Fleets expect a minimum level of performance and durability from the engine products they purchase, with total operating costs equal to or better than the products currently in the fleet. Significant changes to the engine and aftertreatment system, coupled with increased useful life requirements, make it particularly important to minimize the variables that can impact emissions compliance and customer downtime. Requiring that manufacturers allow operation (and testing) on any commercially available biodiesel blends up to B20 is not supportive of those important goals.

The expanded use of biodiesel poses a significant risk to the performance of low-NO_x engine and aftertreatment technologies. While many manufacturers currently approve the use of up to B20, the impact of those fuels in widespread use is still unknown given the currently limited use of biodiesel nationwide. Customers are often unaware of the blend level of the fuel being dispensed when refueling. Despite the limited deployment of biodiesel and low-carbon alternative fuels, OEMs have seen increased incidences of wear and downtime associated with these fuels. Several manufacturers recommend reduced oil change intervals by up to 30% when using B20 or higher blends. In sum, the Agency should not eliminate the current provision allowing manufacturers to restrict operation and testing with B20.

c. The use of biodiesel presents serious risks to in-use compliance and emissions-related maintenance

ASTM specs for biodiesel stability are the lowest in the world. This causes oxidation by-products and raises TAN in the fuel, which either form fuel system deposits, or cause corrosion within the fuel system. This makes the fuel unsuitable for use in any application where the equipment may sit for as little as a week.

The following are real-world examples of problems experienced by customers operating on fuels not meeting specification. These examples illustrate just how sensitive engines and aftertreatment systems are to these contaminants, justifying the need for tighter, well-enforced controls:

- Injector Deposits caused by carboxylate salts from water contamination: Customer complaint with nearly 100% failure rate at two facilities. Both locations had heavy amounts of water, sediment, and significant microbial growth in tank bottoms. One location had >10,000 ppm sodium content (limit <5 ppm). Fungible supply in biodiesel creates acid in the water layer. The presence of sodium and acid combined creates a reaction.

- Injector Deposits caused by carboxylate salts from fungible supply: 3 different customers were having consistent injector failures where all customers were LTL operators and were located in the same area. Two customers fueled at different retail locations, while one customer had its own bulk tank. However, the fuel distributor for all 3 locations was the same fuel terminal. Analysis was nearly identical between all 3 customers – spectrums indicated that the deposit was most likely a carboxylate soap.

- Plugged filters: All customer vehicles activated a "fuel filter plugged" diagnostic within 1 week. Fuel samples ranged from 16-22% biodiesel and all fuel samples failed ASTM D7467 (B6 to B20) standards with an oxidation stability in the range of 3-5 hours. TAN/TBN loss ranged from 0.16 to 0.25 mg KOH/g, all within D7467 limits, but extremely high compared to most fuel samples. All fuel filters showed media collapse and media discoloration once removed. Black gum was extracted from the fuel filter and was analyzed and determined to be consistent with byproducts from biodiesel oxidation.

It is clear from the foregoing that acids in the presence of metal can lead to deposits. Fuel system corrosion causes injector and pump failures from water and fuels with high TAN. Although increased acidity provides increased lubricity, the increase in TAN can lead to deposit formation on fuel injection system hardware.

Prior to implementing compliance requirements on any commercially available B20, manufactures would need to develop sensors that can detect the oxygen concentration or other markers that define the biodiesel fraction in conventional diesel. This will need to be correlated to service frequency requirements to prevent component failures due to loss of oil oxidation and loss of TBN. Given the new emphasis on variable oil life attributed to biodiesel content, manufacturers would also need to update their diagnostic, adaptive calibration and maintenance prognostics to account for variable biodiesel blends and the associated impact to tailpipe emissions. Finally, OEMs would need time to work with lube oil manufacturers and ASTM standards committees to develop oil formulations that are resistant to oxidation and degradation over time.

In addition to the durability concerns discussed above, fuel characteristics have the potential to alter engine out-emissions, as has been reported in CARB's Biodiesel Characterization and NO_x Mitigation Study. Table 1 from that study (reproduced below) illustrates the significantly increased NO_x emissions levels observed when compared to a reference B0 diesel fuel.

Table 5-1. NO_x Percentage Differences Between the Biodiesel Blends and the CARB ULSD base fuel for each Cycle [g/bhp-hr basis].

		2006 Cummins ISM				2007 MBE4000			
		Soy-based		Animal-based		Soy-based		Animal-based	
	CARB vs.	% Difference	P-values	% Difference	P-values	% Difference	P-values	% Difference	P-values
UDDS	B20	4.1%	0.002	-1.5%	0.376	4.4%	0.005	1.6%	0.000
	B50	9.8%	0.000	0.1%	0.935	15.3%	0.000	7.3%	0.000
	B100	17.4%	0.000	1.9%	0.243	36.6%	0.000	16.0%	0.000
FTP	B5	2.2% (Mit)	0.000	0.3%	0.298	0.9%	0.001	1.3%	0.000
	B10	2.6% (Mit)	0.000						
	B20	6.6%	0.000	1.5%	0.000	5.9%	0.000	5.0%	0.000
	B50	13.2%	0.000	6.4%	0.000	15.3%	0.000	12.1%	0.000
	B100	26.6%	0.000	14.1%	0.000	38.1%	0.000	29%	0.000
40 mph Cruise	B5	1.7%	0.135						
	B20	3.9%	0.000						
	B50	9.1%	0.000						
	B100	20.9%	0.000						
50 mph Cruise	B5	-1.1%	0.588						
	B20	0.5%	0.800	-2.3%	0.151	6.9%	0.000	5.9%	0.000
	B50	6.3%	0.001	0.8%	0.588	18.2%	0.000	16.3%	0.000
	B100	18.3%	0.000	5.3%	0.000	47.1%	0.000	39.4%	0.000

CARB Biodiesel Characterization and NO_x Mitigation Study results showing increased engine out NO_x, especially with soy-based biodiesel, the most widely used biodiesel in the US (Biodiesel Characterization and NO_x Mitigation Study, 2011).

The foregoing data further confirm that the requirement to allow the use of any commercially available biodiesel blends will pose serious risks to manufacturers' ability to comply with in-use emissions standards. EMA supports that EPA has proposed to permit manufacturers to use results from fuel sample testing to void in-use test results after-the-fact (see §1036.415(c)(5)), but it is very uncertain whether manufacturers will able to identify improper fuel usage records or otherwise determine the cause of a failed in-use compliance test that might be attributable to previous operation on poor-quality fuels. In the event of a test failure, manufacturers would be compelled to differentiate normal system wear, contamination, or deactivation from that attributed to the use of biodiesel and/or inadequate maintenance procedures appropriate to account for the use of biodiesel. The ability to identify the source of damage resulting from the use of biodiesel may be difficult or inconclusive in many cases. The serious and costly consequences for recall due to compromised in-use compliance could result in manufacturers being compelled to reduce maintenance intervals to mitigate the risk of damage from biodiesel fuels, even to the point of requiring aftertreatment replacement within the useful life period, significantly increasing the cost of vehicles compliant with the new standards.

It is important to reiterate that EPA indicated in the RIA that the impacts of biodiesel would not significantly increase emissions and could be addressed by increasing the catalyst size. However, that data is based on engines compliant to a 0.20 g/bhp-hr NO_x standard rather than the proposed Option 1 or 2 standard, where a "small" increase of just 0.002 g/bhp-hr could render a product non-compliant. That risk is exacerbated by a 800,000 mile useful life requirement.

d. Use of biodiesel can be damaging without well-controlled maintenance procedures

EPA's proposal requires that engine manufacturers "state clearly on the first page of your maintenance instructions that a repair shop or person of the owner's choosing may maintain, replace, or repair emissions control devices and systems." (§1036.125(f)) Repairs performed by independent repair facilities that do not have proper training, and that are installing unapproved third-party components to correct issues caused by the use of biodiesel, can create serious problems. For example, an untrained service technician may install a lower efficiency fuel filter to overcome issues with filter clogging due to operation on biodiesel blends at low temperatures. While this action may appear to have resolved the issue, the impact to the high-pressure fuel system may be significant and catastrophic.

As discussed above, EPA's proposed requirement to allow service by independent repair facilities using third-party emissions control components further jeopardizes the integrity of the manufacturer's design of an integrated fuel, engine and aftertreatment management system critical to compliance with the applicable emissions standards throughout the useful life. In addition, the burden of proof for denying a customer claim for misfuelling, mal-maintenance or use of unapproved biodiesel falls upon the manufacturer at the time of repair. The OEM can accurately determine that damage has occurred, but not *when,* or under what circumstances (e.g., prolonged use of biodiesel) the damage occurred or how fuel deficiencies or deferred maintenance contributed to the failure. Absent the ability to reliably control or know the biodiesel blend level when refueling occurs, it is unrealistic to assume that customers or manufacturers will be able to adequately prescribe an appropriate maintenance schedule that prevents damage from biodiesel use.

Accordingly, EMA recommends expanding the fuel requirements beyond the current ASTM standards to include the more stringent European biodiesel standards and the Top Tier requirements. This would apply to both feedstocks (B100) as well as finish stock. It is widely understood that after metals contamination, poor fuel oxidation stability is a key factor contributing to much of the biodiesel-based engine damage and the cascading downstream collateral damage impacts to aftertreatment.

Additionally, EMA recommends that the applicable regulations explicitly provide for a maximum biodiesel content of 20% nationwide. The emissions impacts from biodiesel increase significantly as blend percentages increases.

Finally, EMA recommends that EPA support updating ASTM D975 and D7467 to reduce the allowable concentrations of Calcium, Magnesium. Sodium, Potassium and Phosphorous. EMA stands ready to work with EPA and other stakeholders to determine appropriate limits for those properties, reducing them to levels in the range of 1ppm. These new fuel standards should be developed based on industry experience, experimental data, and supplier input, and should be enforceable at the pump.

In addition to these finished fuel specifications, EMA recommends improvements to the B100 feedstock specification as well, to help enable higher quality finished fuels with biodiesel content. The following B100 specifications and recommendations refer strictly to B100 as a blendstock and not as a finished product.

To summarize, EMA opposes the requirement that manufacturers must comply on any commercially available biofuel meeting current ASTM D975 or ASTM D7467 standards. Manufacturers should be permitted to continue to specify the maximum allowable biodiesel blend levels for their products, and vehicles operating on, or having operated on, fuels inconsistent with the manufacturers' recommendations, should not be required to comply with the final standards. In addition, EPA should take action to assist in the development and enforcement of the improved biofuel specifications listed above before holding manufacturers liable for compliance when operating on such fuels. Only after improved fuel quality standards are developed, implemented, and enforced at the pump can the industry embrace the widespread deployment of alternative fuels, and promote their usage, so as to realize the rapid and significant reductions in GHG emissions they might offer.

e. EPA should consider whether the new standards will require improved lubricant formulations

EPA also should consider the possibility that the proposed standards could compel new engine oil formulations. Engine lubricants perform critical functions, including reducing engine wear, enhancing fuel efficiency, and providing protection for the engine and its emissions control systems. The proposed low-NO_x standards and extended useful life and warranty periods could have significant impacts on those functions. New oil formulations have been required in response to reduced emissions standards in the past. EPA should account for this possibility in its implementation schedule for the proposed regulations.

16. The Proposed Option 1 Low-NO_x Regulations Likely Would Be Cost-Prohibitive

Independent experts at Ricardo and the National Renewable Energy Laboratory (NREL) have conducted a comprehensive cost study regarding the proposed low-NO_x requirements and have determined that regulations centered around Option 1 would result in an approximate $42,000 per-vehicle cost increase (in 2017 dollars – the metric EPA has used) for heavy heavy-duty (HHD) vehicles, when factoring in increased operating costs.

On the benefits side, independent experts at NERA Economic Consulting ("NERA") previously have determined through a "scoping study" that the range of potential monetized health benefits from the implementation of the proposed low-NO_x regulations, when focusing primarily on potential reductions in secondary $PM_{2.5}$ and ozone, as EPA is doing in its benefits analysis, and without accounting for exposure-extrapolation uncertainties, could be as high as approximately $4,500 per-vehicle. (Copies of the Ricardo and NERA Reports, which are discussed in greater detail below, are attached hereto as **Exhibits "B" and "C"**.)

Using the foregoing numbers, on a per-vehicle basis, the proposed Option 1 low-NO_x regulations likely would have a costs-to-benefits ratio (or a negative benefits-to-costs ratio) on a per-HHD-vehicle basis of approximately 10:1. As a result, Option 1 is not implementable. In addition, EPA will need to revise Option 2 in a manner consistent with EMA's recommendations to enhance the cost-effectiveness of the Agency's final low-NO_x regulations.

a. EPA's analysis understates the costs of the Low-NO_x Regulations

EPA's cost assessment, as presented in the RIA, stands in sharp contrast to the detailed cost assessments that Ricardo and NREL have prepared. The primary difference between EPA's cost "teardown" assessment, which did not rely on input from HDOH engine and vehicle manufacturers, and those that Ricardo and NREL developed, which did utilize manufacturers' input, relates to whether the extended Option 1 UL periods would compel manufacturers to factor-in the costs of a replacement aftertreatment system (or multiple aftertreatment system components) at or before the 500,000 mile point. Ricardo and NREL, based in part on direct input from manufacturers, concluded that the replacement of aftertreatment system components likely would be required within the Option 1 extended UL period. EPA has assumed otherwise. In the NPRM, EPA offers only the following conclusory statement for its contrary position:

> We believe our proposed useful life periods are feasible and would not require manufacturers to adopt component replacement as part of critical emission-related maintenance strategies. (87 FR at p. 17496.)

EMA fundamentally disagrees. The known degradation of catalyst substrates and related components, including as observed with EPA's Stage 3 prototypes, creates material risks of non-compliance with the proposed Option 1 requirements, especially if the UL period is extended out to 800,000 miles. Manufacturers will have to account for and mitigate those risks in developing their compliance and maintenance strategies, and likely will include aftertreatment component replacements as manufacturer-covered maintenance at or before 500,000 miles. The risk of recall liability – which liability can amount to several hundred million dollars – is simply too high to rely on a different strategy. Assuming that all SCR systems can maintain better than 99.5% conversion efficiencies and can maintain steady NO_x levels no higher than 0.04 g/bhp-hr all the way out to 800,000 without aftertreatment component replacement is not reasonable.

The cost to the manufacturer to schedule replacement of the aftertreatment system is significant. If EPA were to misjudge whether manufacturers will have to bear the cost of scheduled aftertreatment systems within the extended UL periods (and pass that cost on to customers at the time of purchase), it will have a significant bearing on the benefits-to-costs ratio.

EMA acquired actual cost data from four manufacturers reflecting what they pay in total to a dealer when a current HHDDE US10 aftertreatment package is replaced under warranty. Those costs, including labor, ranged from approximately $6,500 to $17,750.[31] Again, those are costs associated with *current* aftertreatment configurations. Ricardo estimates the cost of aftertreatment systems consistent with the Stage 3 solution will further increase by $2,588, with labor costs potentially impacted significantly due to the additional time required to access, extract and replace the LO-SCR packaged as close to the turbocharger as physically practical. Thus, in total, EPA is dismissing as much as $20,000 in costs with its unsupported assumption that those systems would not require replacement within the extended ULs. That assumption is wholly incorrect.

In its assessment of this critical cost issue, EPA has acknowledged that its assumption is contrary to the data-driven assessment that NREL made when it conducted a cost analysis of CARB’s version of Option 1. In its RIA, EPA has offered the following explanation of its disagreement with NREL:

> We are aware of a recent study conducted by the National Renewable Energy Lab (NREL) for the California Air Resources Board (CARB). In that study, NREL surveyed parts suppliers and engine/vehicle manufacturers regarding estimated costs associated with the [Stage 3] technologies being considered within the context of CARB's Heavy-Duty Low NO_x program. As part of that study, NREL considered costs associated with increased warranties and increased useful life periods being considered by CARB. Our understanding is that, while the costs associated with [Option 1] warranty and useful life are quite high, they were in fact estimates associated with complete system replacement at some point during the extended useful life of the engine/vehicle. *We have assumed* that manufacturers would not pursue such an approach and would, instead, include upfront (i.e., at the point of end user purchase) with the expectation that the parts would last the full useful life without a mandatory replacement [sic]. For that reason, we have chosen not to use the warranty and useful life estimates presented by NREL and have instead used [our own] approach. (RIA, p. 327.) (Emphasis added.)

The foregoing explanation makes it clear that EPA’s disagreement with NREL (and Ricardo) is based more on opinions and assumptions than data. That is not sufficient to support a rulemaking of this magnitude.

[31] Labor consistently represented well less than $1,000 within these costs. Costs did not include ECU’s, wiring harnesses, DEF injectors, or pressure or temperature sensors.

Notwithstanding EPA's choice, in effect, to disregard NREL's work, the NREL cost study that CARB commissioned is, in fact, very instructive. As an initial matter, it confirms that, when attempting to assess indirect costs, such as the potential impacts of expanded warranty and UL requirements, OEMs are the entities best positioned to estimate those costs, which implicitly confirms that EPA's indirect "teardown" cost-assessment method – i.e., scaling from previously established "RPE factors" for warranty costs and R&D (RIA, p. 325) – is not an optimal approach. NREL's specific conclusions on that point is as follows: "Engine OEM participation was crucial, as only they could provide estimates for indirect costs that represented a significant portion of the total cost. Incremental costs are largely driven by indirect costs associated with engineering research and development costs and warranty costs. Indirect costs are highly dependent on production volumes over which to amortize research and development costs. Indirect costs due to warranty are high, reflecting high uncertainty with new technologies and the introduction timeframes." (NREL Report, p. vii,)

The NREL Report is most telling, of course, in the bottom-line results it presents. Specifically, the NREL Report concludes that for HHD vehicles, the per-vehicle cost for compliance with CARB's version of Option 1 would range from $28,868 to $47,042, with the higher range being the more likely outcome. That number is an order of magnitude greater than the per-vehicle costs that EPA has posited (i.e., $4,213 per-vehicle for HHD vehicles; see RIA, p. 329, Tables 7-19 and 7-20), and is consistent with the detailed cost analysis that Ricardo has prepared based on nationwide HHD sales volumes (discussed infra).

With respect to the incremental per-vehicle costs associated with Option 1-like extended emission warranties and ULs, NREL concluded that, on average, those aggregate indirect costs would range from $23,424 to $38,898. (See NREL Report, pp. vii-viii, 40, and Table 20.) That too is largely consistent with Ricardo's findings, and confirms that the majority of the incremental costs that would result from the implementation of Option 1 would stem from the proposed significant increases in ULs and emission warranties. As discussed in more detail below, Ricardo concluded that the indirect incremental costs associated with the Option 1 ULs and warranties would be as high as approximately $27,000 (in 2017 dollars) per-vehicle, within the range posited by NREL. (See Ricardo Report, Table 26.) In contrast, EPA has posited that the incremental per-vehicle costs stemming from the Option 1 extended UL and emission warranties will only amount to approximately $1,300 for vehicles. (See RIA, pp. 329-330.) Once again, the EPA cost estimates differ markedly from NREL's and Ricardo's more reasonable and data-based conclusions by at least an order of magnitude.

In addition to dismissing the need to account for aftertreatment replacements, and, as a result, substantially understating the UL and warranty costs at issue, EPA's cost assessment also relies on an under-inclusive and inapt estimation method for indirect costs. At pages 323-325 of its RIA, EPA describes its use of previously established "retail price equivalent (RPE) multipliers" to calculate the indirect costs that can be derived from the ratio of revenues-to-direct costs. As EPA explains it, "using RPE multipliers [ranging from 1.28 to 1.5] implicitly assumes that incremental changes in direct manufacturing costs produce common incremental changes in all indirect cost contributors as well," including the costs associated with substantially extended UL and emissions warranty periods. (RIA, p. 323.) EPA applies this proportional methodology notwithstanding the Agency's recognition that, "[t]he use of RPEs, with their assumption that all technologies have the same proportion of indirect costs, is likely to overestimate the costs of less complex technologies and underestimate the costs of more complex technologies." (RIA, p. 323.)

This rulemaking clearly involves a whole suite of new "more complex" technologies. Nonetheless, and despite its own admonition, the Agency has proceeded to rely on the implicit assumption that all of the quantumly increased indirect costs at issue will remain uniformly proportional to the increased direct costs at issue. Applying this "implicit assumption," EPA then accounts for the cost of the proposed extended UL and warranty periods by applying additional "VMT-based scaling factors" to the R&D and Warranty costs derived from the underlying RPE-based calculations of indirect costs. (RIA, p. 325.) For example, when assessing the indirect cost impacts from extending the current warrant periods from 100,000 miles initially to 450,000 miles, and then to 600,000 miles under Option 1, EPA offers the following explanation of its VMT-scaled RPE-based methodology:

> Proposed Option 1 would extend the required warranty period for a Class 8 diesel to 7 years or 450,000 miles for MYs 2027 through 2030, and then extend further to 10 years or 600,000 miles for MY 2031 and beyond. As such, in our analysis of proposed Option 1 for Class 8 diesel trucks we applied a scaling factor of 4.5 (450/100) to the 0.03 [RPE-based] warranty cost contribution factor for MYs 2027 through 2030, and applied a scaling factor of 6.0 (600/100) for MYs 2031 and later. The same approach is followed for the other regulatory classes (RIA, p. 325.)

There are multiple concerns with EPA's VMT-based RPE-derived scaling approach to assess UL and warranty costs. At its core, EPA's analysis assumes that the indirect costs attributable to the significantly extended UL and warranty periods will increase on a linear VMT-weighted basis from the previously-derived RPEs that the Agency "used in prior rule-makings setting new greenhouse gas standards for heavy-duty trucks." (RIA, p. 324.) That is not a sound assumption, as detailed in Ricardo's Report.

EPA's low-NO_x proposal will require manufacturers to develop and rely on the types of innovative highly-complex and multi-component aftertreatment systems that have been used in EPA's Stage 3 RW prototype. Those advanced and complex integrated systems, including CDA, are entirely new for HDOH engines, as are the combinations and configurations in which they are being deployed at SwRI. Manufacturers have no prior experience using or packaging those new multi-component systems in the field, and do not know how they will age and whether they can consistently make it out to the substantially extended Option 1 ULs without needing to be replaced. Thus, using linear VMT-based extrapolations from old RPE-based factors to assess the indirect costs associated with these entirely new highly-complex systems and configurations, which will have compliance obligations far beyond any previously proven points of component durability, is not a sound or reasonable methodology.

Manufacturers do not have prior experience with these new "Stage 3" systems. Thus, there is no basis to assume that the resultant indirect costs associated with the extended ULs and emission warranties will be uniformly proportional to the direct manufacturing costs associated with those Stage 3 systems. Simply stated, there is not sufficient data to support the Agency's assumption that future warranty and UL costs will amount to a VMT-based linearly-scaled increase from previously calculated RPEs, and that no separate considerations need to be given to whether the magnitude of those indirect costs should include the costs of replacement aftertreatment components. Consequently, the indirect cost estimates that EPA has derived from its extrapolation method are not reasonable.

The net result is that EPA's assessment of the aggregate per-vehicle incremental cost impacts from its Option 1 proposal are significantly understated – most likely by an order of magnitude. Focusing on Class 8 vehicles, EPA estimates that the total incremental per-vehicle costs from implementing Option 1 will be $4,213 in MY 2027, and $3,931 in MY 2031. With respect to the indirect-cost portion of that total incremental cost amount, the Agency estimates that for the extended ULs (treated as R&D costs) and emission warranties at issue, those indirect costs will amount to $1,251 per-HHD-vehicle in 2027, and $1,458 per-HHD-vehicle in 2031, as reflected below in Tables 7-20 and 7-21 from the Agency's RIA (RIA, pp. 329-330):

Table 7-20 MY 2027 Average Per-Vehicle Technology Costs (HHD8 Diesel)

	Manufacturing Direct/Costs	Warranty	R&D	Other	Profit	Sum of Tech Cost
Option 1 Increase from Baseline	$2,210	$976	$275	$641	$111	$4,213

Table 7-21 MY 2031 Average Per-Vehicle Technology Costs (HHD8 Diesel)

	Direct Manufacturing Costs	Warranty	R&D	Other	Profit	Sum of Tech Cost
Option 1 Increase from Baseline	$1,851	$1,227	$231	$537	$93	$3,931

As noted, these per-vehicle incremental cost estimates are more than an order of magnitude lower than those derived by NREL and Ricardo. They also utilize an unrealistic "learning curve" to derive even lower estimates for the overall MY 2031 cost projections. In addition, they assume that the more stringent requirements for 2031 MY products will result in lower incremental costs than the less stringent requirements for MY 2027 products. Simply stated, EPA's cost estimates are not reasonable.

As detailed next, Ricardo has developed a far more robust assessment of the cost impacts of EPA's Option 1 proposal, including the indirect costs attributable to EPA's proposed extended ULs and emission warranties. The Agency will need to account for Ricardo's detailed analysis and data-driven conclusions (as well as Ricardo's critique of the Agency's cost assessment) before finalizing this rulemaking.

b. The Ricardo Study demonstrates that EPA's cost estimates are too low

EMA retained Ricardo to conduct a comprehensive assessment of the direct and indirect costs, as assessed on a per-vehicle basis, that likely will result from EPA's implementation of the low-NO_x regulations, particularly with respect to new regulations centered around Option 1. The Ricardo compliance cost assessment (**Exhibit "B"** hereto) is based on its exhaustive review of public data sources, evaluation of recommended cost-estimation methods, and a detailed survey and analysis of the HDOH vehicle and engine manufacturing industry, which Ricardo completed in mid-2021 and then updated in 2022. Table 26 from the Ricardo report, reproduced below, summarizes Ricardo's findings regarding the aggregated per-vehicle cost impacts from EPA's Option 1 and Option 2 proposals:

Table 1: Ricardo Cost Incremental Cost Analysis Summary (adjusted to 2017 $)

		Ricardo Incremental Cost					
		2021 $			2017 $		
		Option 1		Option 2	Option 1		Option 2
		2027	2031	2027	2027	2031	2027
Direct Manufacturing Costs	**Engine Hardware**	**1,824**	**1,989**	**1,659**	**1,643**	**1,792**	**1,495**
	Cylinder deactivation	1,381	1,512	1,249	1,244	1,362	1,125
	Other Associated Engine Costs	112	121	104	101	109	94
	Calibration	22	22	22	20	20	20
	EGR Cooler Bypass	194	211	176	174	190	158
	Other required incremental engine technologies	115	123	108	104	110	97
	Aftertreatment Systems	**2,349**	**2,588**	**2,109**	**2,116**	**2,332**	**1,900**
	CDPF	0	0	0	0	0	0
	DOC	0	0	0	0	0	0
	SCR	1,833	2,009	1,656	1,651	1,810	1,492
	Canning	0	0	0	0	0	0
	HC Dosing	460	517	402	414	466	362
	Aftertreatment control & calibration	56	62	51	51	56	46
	Vehicle Changes	**168**	**188**	**149**	**152**	**170**	**134**
Indirect Costs	**Other Costs**	**16,361**	**29,917**	**13,944**	**14,739**	**26,952**	**12,562**
	Warranty	9,942	16,268	5,800	8,957	14,655	5,225
	R&D	234	529	258	211	477	233
	Lab & Equipment	39	39	39	35	35	35
	In-use Testing	6	6	5	5	6	5
	Onboard Diagnostics	47	65	57	42	58	52
	Extended Useful Life	660	1639	876	595	1477	790
	Repair & Maintenance	5,432	11,372	6,907	4,894	10,245	6,223
Operating Costs	DEF	**11,993**	**11,993**	**7,176**	**10,805**	**10,805**	**6,465**
Total		**32,695**	**46,675**	**25,037**	**29,455**	**42,051**	**22,556**

As reflected above, Ricardo estimates that the per-vehicle incremental costs for HHD vehicles under EPA's Option 1 will total $42,051 (in 2017 dollars) as of 2031, including increased operating costs. When Ricardo's per-vehicle cost number is compared against EPA's estimated per-vehicle cost number ($3,931 for HHD vehicles in 2031), it is clear (again) that EPA has understated the per-vehicle costs of its proposed rulemaking by an order of magnitude. The same conclusion holds when comparing Ricardo's calculation of likely per-vehicle HHD warranty, UL and component replacement costs in 2031 ($26,376) with EPA's calculation of those indirect costs ($1,458).[32]

Unlike EPA's cost assessment, Ricardo conducted an actual comprehensive survey of all leading OEM's to assess the likely direct and indirect cost impacts of the Option 1 standards, and so was able to make detailed determinations of the per-vehicle direct and indirect cost impacts that will result from EPA's proposal as of 2027 and 2031. As explained in the Ricardo Report, the cost-

[32] It is worthy of note that EPA significantly underestimated the costs of its last HDOH rulemaking by at least a factor of four (4). See ATF Report, Feb. 2012, "A Look Back At EPA's Cost And Cyber Impact Projections For MY 2004-2010 Heavy-Duty Truck Emission Standards."

assessment that Ricardo utilized is inherently more reasonable and robust than the assumption-driven and extrapolation-based approach that EPA has taken.

From the foregoing comparisons of cost estimates, it is clear that the main differences between EPA's estimates and Ricardo's relate to the direct costs for CDA systems, and the indirect costs associated with the proposed extensions of emissions warranty and UL periods. More specifically, EPA assumes that the all-in per-vehicle costs associated with the deployment of the required complex CDA systems will be only $206, a number that EPA derived from assessing costs at the component-supplier level. Ricardo, on the other hand, based its assessments of all of the relevant CDA-integration costs at the OEM level, and has calculated those per-vehicle costs to be $1,512. (See Ricardo Report, p. 20.)

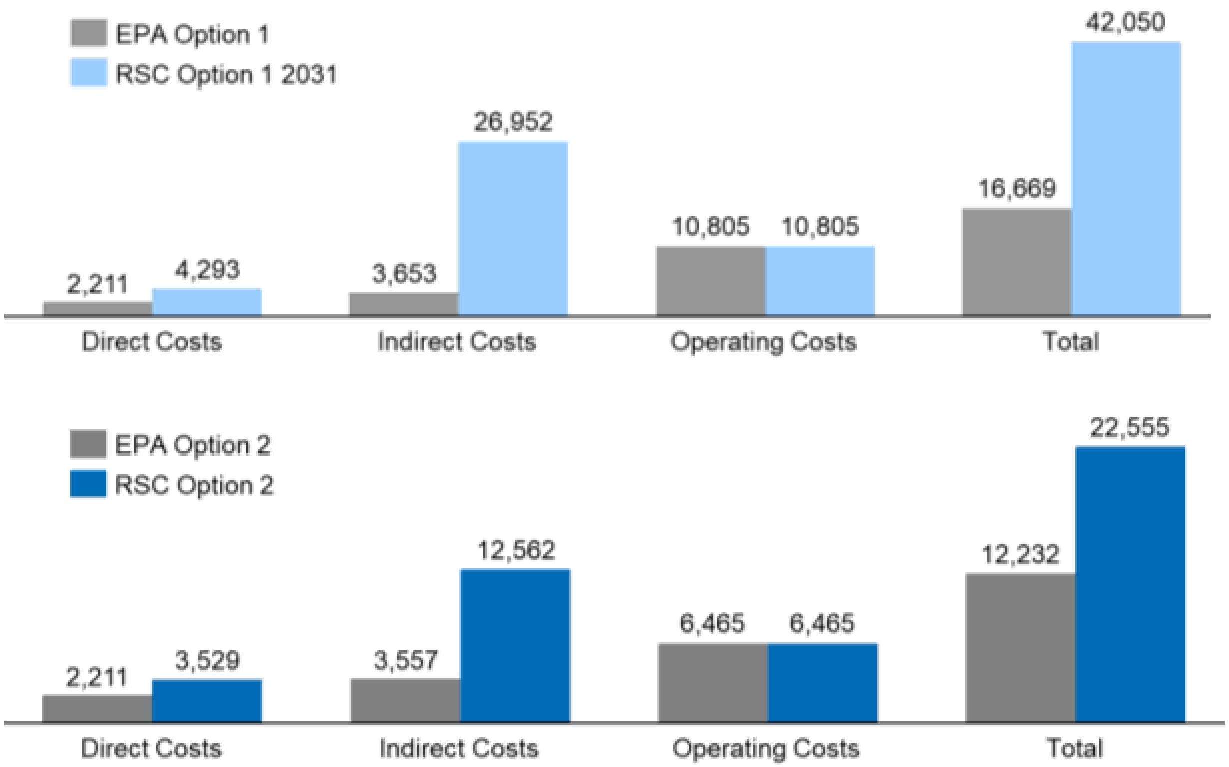
Beyond that. the more significant cost differentials stem from how EPA and Ricardo have estimated the per-vehicle costs associated with EPA's proposals to extend the regulatory UL and emissions warranty periods. EPA's estimate of those costs (as adjusted upward by Ricardo) — based on the Agency's assumption that aftertreatment components will not need to be replaced during the extended UL period — amounts to just $2,373 per vehicle, a figure that is inherently unrealistic and that is less even than CARB's much shorter "Step 1" warranty, as discussed further below. Ricardo, on the other hand, based on real data from OEMs, and on the OEMs' direct confirmation that ERCs will need to be replaced if an 800,000 mile UL is mandated, has calculated that the actual incremental per-vehicle UL and warranty costs will be $26,376. Here too, EPA has under-estimated the actual incremental costs of Option 1 by more than an order of magnitude. Ricardo's Report explains these critical differences with greater particularity, and demonstrates that EPA's cost projections are unreasonable, which means that they are an insufficient basis for this rulemaking.

A side-by-side comparison of the cost elements of EPA's Option 1 and 2 proposals, as estimated by EPA and by Ricardo is set forth below:

Table 2: EPA vs. Ricardo Incremental Cost Comparison

Incremental Costs (2017$)		EPA Option 1	EPA Option 2	Ricardo Option 1		Ricardo Option 2
				2027	2031	
Direct Costs	Engine Hardware	243	243	1,643	1,792	1,495
	Aftertreatment Systems	1,968	1,968	2,116	2,332	1,900
	Vehicle Integration			152	170	134
Indirect Costs	Warranty	1,367	717	8,957	14,655	5,225
	R&D	529	323	211	477	233
	Other	641	641			
	Profit	111	111			
	Lab & Equipment			35	35	35
	In-use Testing			5	6	5
	Onboard Diagnostics			42	58	52
	Extended Useful Life (includes repair & maintenance)	1,006	1,766	5,489	11,721	7,012
Operating Cost	DEF	10,805	6,465	10,805	10,805	6,465
Total		**16,670**	**12,234**	**29,455**	**42,051**	**22,556**

Figure 1: Breakdown of EPA vs. Ricardo Cost Comparison



As already discussed, EPA's order-of magnitude miscalculations of cost are rooted in large part in the Agency's unsupported assumption that manufacturers will not fully adjust the costs of their HHD and MHD vehicles to recoup the full projected costs that will result from EPA's proposals to extend emission warranties and regulated FULs, and from the increased compliance liabilities that will stem from the substantially expanded list of emissions-related components that will be covered under the lengthened warranties. But it is fundamentally unreasonable to assume that manufacturers will choose to absorb the quantumly increased costs and risks of the low-NO_x regulations, and so will not attempt to fully recoup those costs through corollary vehicle price increases. Based on consistent historical experience, and as a matter of sensible business practice, manufacturers will calculate and fully recoup those regulatory costs through corollary per-vehicle price increases.

c. Other data establish that EPA's UL and warranty cost estimates are unreasonable

EPA has tied the cost-effectiveness of its Option 1 proposal to the unsupported assumption that the replacement of aftertreatment components will not be necessary, and that the incremental indirect costs associated with extending the HHD UL period from 435,000 miles to 800,000 miles, along with extending the emissions warranty period from 100,000 miles to 600,000 miles as of 2031, will only total $1,458 per-vehicle. (See RIA pp. 329-330.) That is well off the mark.

Currently available market data and pricing information show that the incremental costs associated with CARB's "Step 1" extended emission warranties — which went into effect this year, and which extend those warranties for HHD vehicles from 100,000 miles to just 350,000 miles — amount to approximately $2,500 per-vehicle. That is what the extended "Step 1" warranty requirements actually add to the cost of HHD vehicles that are actually being bought and sold in the market today. What this shows, therefore — and, in fact, proves — is that EPA is unreasonably assuming that an emission warranty that is more than 70% longer than CARB's "Step 1" warranty as of 2031 will cost approximately 25% less than the actual cost of the much shorter "Step 1" warranty today. EPA's assumption in this regard is obviously and fundamentally wrong, as further underscored by Ricardo's (and NREL's) analyses.

EMA took additional steps to evaluate EPA's emissions warranty cost projections, turning to two sources of actual warranty cost data for warranties that extend long beyond the current baseline regulated emission-related component ("ERC") warranties, and also beyond manufacturers' "base" powertrain warranties (that also cover emissions-related components). The first additional analysis is based on pricing rates of aftermarket warranty packages, and the second is based on HHDDE manufacturers' actual warranty costs incurred when customers purchase extended warranty packages. Both of these additional analyses show (again) that EPA's cost projections related to the proposed extended emissions warranty coverage requirements are grossly understated.

EMA consulted with one of the largest aftermarket warranty companies in the U.S. to understand the warranty products they offer and the pricing structure for them. Those warranty packages include certain component groupings, such that ERCs (including aftertreatment systems) can be segregated for comparison against the company's price sheet. Pricing was set up based on the included component packages, the age and mileage of the vehicle to be covered, and the years and mileage of extended the warranty coverage. It was therefore possible to estimate the subscription price to cover an additional warranty period from today's ERC warranty coverage (which we assumed to be 5 years/250,000 miles to account for the combination of the 5 year/100,000 mile regulated ERC warranty and the typical manufacturer's warranty of 2 years/250,000 miles) to EPA's proposed Option 1 extended warranty period of 10 years/600,000 miles.

The aftermarket warranty provider's business model involves relying on OEM dealer networks and provider-approved independent repair centers to perform warranty repairs that are subsequently billed to the provider. This means that the warranty provider does not operate any vehicle repair centers, and does not employ or train any repair technicians. Instead, the provider simply reviews repair invoices and pays the OEM dealers and repair centers from the funds accumulated from the customers' extended warranty subscriptions. Under this model, EMA assumed a 20% profit margin should be subtracted from the pricing model to estimate the actual *costs* of the ERC warranty repairs.

Using this information, it was a relatively straightforward mathematical exercise to draw parallels between the aftermarket extended emissions component warranty coverage costs, and EPA's extended warranty costs. The aftermarket warranty costs included in this additional analysis were limited to the ERCs in current US10-compliant products. Future warranties, however, will also be compelled to cover any new emissions-related components deployed by manufacturers to comply with the proposed 2027 and 2031 emissions standards. To estimate those warranty costs, EMA multiplied the aftermarket warranty costs by the ratio of future emissions-related component costs to current emissions-related costs. Current ERC costs were estimated to be $10,000 for a

HHDDE, and future costs were estimated at approximately $4,000 (See Ricardo Report, Table 22). For the new ERC's, the warranty costs from 0 miles to today's ERC warranty coverage was estimated by the same component cost ratio approach.

The resultant warranty cost increase to engine manufacturers calculated from this analysis process was approximately $11,900 per HHDDE. There are two other factors that should be considered in this analysis. The first is the impact that the extremely stringent proposed NO_x standards may have on warranty costs of existing (US10-compliant engine) components. This factor can manifest itself in the following ways: (1) the cost of various components could increase to support longer UL requirements, (2) the OBD system may more often trigger the MIL due to faults of the existing component set due to the overall greater complexity of the Stage 3 system, increasing frequency of repair, (3) EPA's new requirements in §1036.120(c) will expand the current ERC list to include "all components whose failure would increase emissions," and (4) the inspection and maintenance programs being implemented by various states will increase repair frequency. (See Ricardo Report, Tables 22 and 30.)

The second factor that could increase the cost of emissions warranties beyond the estimation from this analysis stems from the fact that new technologies (e.g., CDA, EGR cooler bypass, heated DEF doser, and NH_3 sensors, which have seen only limited use to date) or new applications of existing technologies (e.g., close coupled SCR) can experience higher failure rates in the early years of production than those of more mature components. Recall that the warranty cost projection for the new (Stage 3-based) ERCs in this analysis was based on the cost ratio of the new ERCs to the existing ERCs, where the existing ERCs are mature components with mature failure rates. An adjustment would be required to account for the historical, and unavoidable, elevated failure rates for new components.

For the purpose of this analysis, if we assume an increase in warranty costs for existing components of 20% for the first factor described above, and a 20% elevated failure rate for new technologies and new applications of existing technologies as described for the second factor, the estimated increase to warranty costs relative to today's products is approximately $14,900.

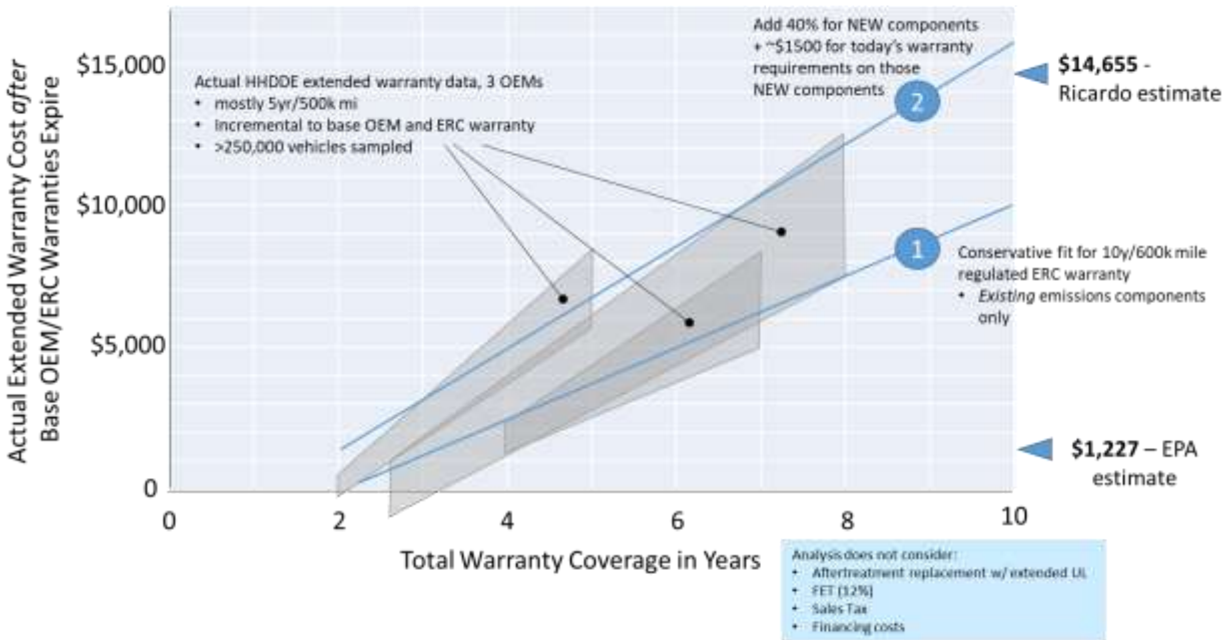
While admittedly a somewhat crude analysis, this estimation has its basis in real-world expenses that are being incurred today. There may be some elements in the analysis that could be revised, but the point is not to use the process to get a precise estimation of warranty costs for rulemaking purposes; rather, it is to check the scale of EPA's estimates against *actual* data available today. In that regard, EPA's warranty cost estimates ($976 to $1,227) are, once again, clearly understated by an order of magnitude. Indeed, if EPA's estimates reflected a more accurate assessment of extended warranty costs, that would imply that purchasers of aftermarket warranties are paying multiple times the value they get from those coverages, an outcome highly unlikely given how astute most trucking companies are when it comes to controlling costs and managing their businesses.

The second analysis EMA conducted offers a more direct assessment of extended warranty costs. EMA obtained from OEMs actual data reflecting the warranty costs that those OEMs have incurred when customers purchased extended warranty packages. Three manufacturers culled their warranty expense databases to collate the warranty coverage expenses incurred from the time a vehicle passed the point of a standard warranty (combination of regulated ERC warranty and the manufacturer's base warranty) to the end of the purchased extended warranty period.

The graph below shows the range of extended warranty costs incurred on emissions-related components by these three HHDDE manufacturers. To be clear, this is a data-capture of actual costs *incurred* from extended emissions warranty repairs, not how much the manufacturers charged the customer for the extended warranty. Most of the data is based on purchased extended warranties to approximately 5years and 500,000 miles, though some included longer warranty coverage periods. Each manufacturer's input is shown in the graph as a shaded area. The analysis was based on average per-vehicle costs from a population of covered vehicles. The data is represented as a range through the shaded areas because each manufacturer had his own way of sharing the data depending on how their tracking systems were structured. (For example, one OEM provided three consecutive model years of data, while another tracked the figures by low-HP range and high-HP range within a platform.) In total, data from more than 250,000 engines is included in the following graph:

Once again, it is clearly evident from this *actual* ERC incremental cost data – incremental to base warranty costs -- that EPA's incremental cost estimates attributed to the proposed extended warranty requirements are significantly understated. Importantly, the data presented above is based on today's ERCs installed in US10-compliant engines. Even though the data above does not include the additional ERCs that will be required to comply with the new low-NO_x emissions standards, the costs as captured are nonetheless significantly greater than EPA's projections that do include those additional components.

It is instructive to apply the cost ratio techniques used in the aforementioned aftermarket warranty analysis to these real-world actual cost-data to project what the "all-in" incremental warranty costs could be. Considering the graph below, we might conservatively assume that the line indicated by the circled marker "1" is a conservative projection of warranty costs that would be incurred on today's *existing* ERC's if subject to a 10year/600,000 mile warranty. If we apply the cost ratio technique of the aftermarket warranty data analysis to estimate the warranty cost coverage on existing and the new ERCs, that would move the estimation to the level indicated by the "2" marker as shown. This second estimation includes the estimated cost of the warranty to cover the new ERCs from mile 0 to today's emissions warranty.



Also noted on the graph above, for reference, is the Ricardo estimate of incremental ERC warranty costs resulting from the EPA proposal, which aligns very well with the extrapolated cost estimation. Finally, the EPA estimate of $1,227, an order of magnitude lower, is noted.

It is very safe to conclude from these two additional analyses – the aftermarket warranty analysis and the actual purchased extended warranty costs analysis – both of which are based on real-world experience, that EPA's projection of incremental ERC warranty costs is grossly understated. While the detailed underlying cost information used to conduct these analyses is not included in these comments for confidentiality reasons, EMA is open to discussing these analyses in more detail with EPA. In that regard, it is imperative for EPA to correct its cost assessment in order to fashion a final rule that can be implemented in a cost-effective manner.

d. EPA's analysis does not account for the anticipated Pre-Buy/No-Buy response to the proposed regulations

Significantly, EPA's cost-benefit analysis also does not adequately account for the significant pre-buy/no-buy impacts that the proposed low-NO_x regulations will cause. To the contrary, EPA downplays the potential impacts of any pre-buy/no-buy market response, claiming that "our results for proposed Option 1 suggest pre- and low-buy for Class 8 trucks may range from zero to approximately two percent increase in sales over a period of up to 8 months before the 2031 standards begin (pre-buy), and a decrease in sales from zero to approximately two percent over a period of up to 12 months after the 2031 standards begin (low-buy)." (87 FR at p. 17429.)

As detailed below, that is a fundamentally unrealistic assessment of how the HD vehicle market is likely to respond to Option 1.

The HD commercial vehicle truck market is very sensitive to the introduction of new technology-forcing emissions regulations. The most recent example of that is when EPA and CARB implemented a 90% reduction in the PM standard for 2007 MY and later heavy-duty engines, which required the introduction of diesel particulate filters into the HD marketplace. In parallel, NO_x standards were reduced by 50%. HD vehicle purchasers, wary of the cost and reliability implications of the major new HDOH technology launches, significantly accelerated their vehicle-replacement purchasing cycles in 2005 and 2006 to avoid purchases of the new-technology vehicles in 2007 – the classic manifestation of a pre-buy/no-buy response to new aggressive emissions regulation. More specifically, in the Class 8 market, vehicle purchases ramped-up significantly in 2005 and 2006, with the result that 40% more vehicles were sold in 2006 (284,000 units) than in 2004 (203,000). In 2007, the market then dropped by a full 47%, to just 151,000 units. Among the other adverse consequence of that pre-buy/no-buy response, air quality benefits were delayed, and very significant layoffs ensued at vehicle assembly plants and powertrain production facilities, with similar cascading unemployment effects and other dislocations throughout the HDOH supply chain. See Polk Automotive Services Data; ATD's Report, "Look Back at EPA's Cost and Other Impact Projections for 2004-2010 HDOH Standards" (Feb. 13, 2012); UAW Comments (Oct. 15, 2015; RIN 2060-A816). See also ERG Report, "Analysis of Heavy-Duty Vehicle Sales Impacts Due to new Regulations" (May 2021, EPA-420-R-21-013).

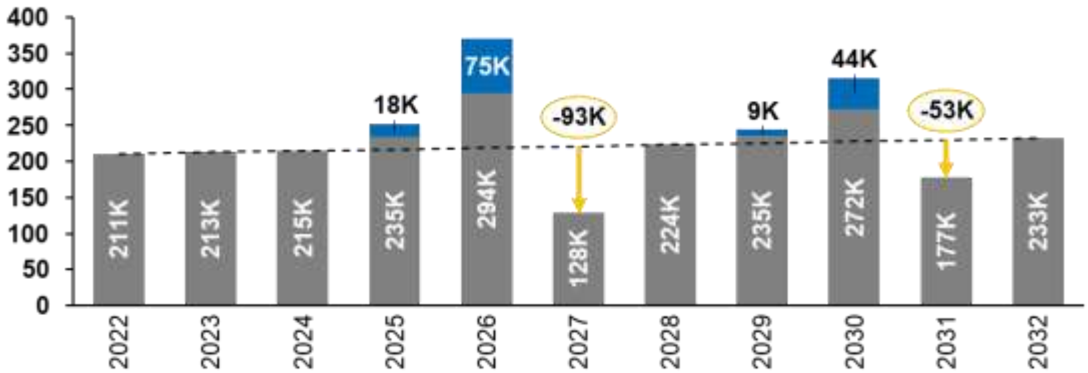
With respect to this rulemaking, Ricardo and ACT Research Group (ACT) have conducted a detailed analysis of the pre-buy/no-buy vehicle-purchasing practices that HD vehicle fleet-operators likely would engage in to try to avoid the cost and other impacts of the proposed low-NO_x regulations, with specific reference to Option 1. As set forth in Tables 32 and Figure 8 of the Ricardo Report (reproduced below), EPA's Option 1 low-NO_x regulations likely would result in an initial "pre-buy" of approximately 93,000 Class 8 vehicles, followed by a second two-year pre-buy in advance of the 2031MY that would amount to approximately $53,000 Class 8 vehicles — for a total of approximately 146,000 "pre-bought" HHD vehicles. A pre-buy of that magnitude would eliminate a correspondingly large percentage of EPA's assumed emission-reduction benefits from the low-NO_x regulations, and would cause an additional increase in the per-vehicle costs resulting from the proposed regulations, given the reduced number of new vehicles that would be sold and therefore available to recoup the costs of the regulations.

Table 3: Predicted pre-buy volumes

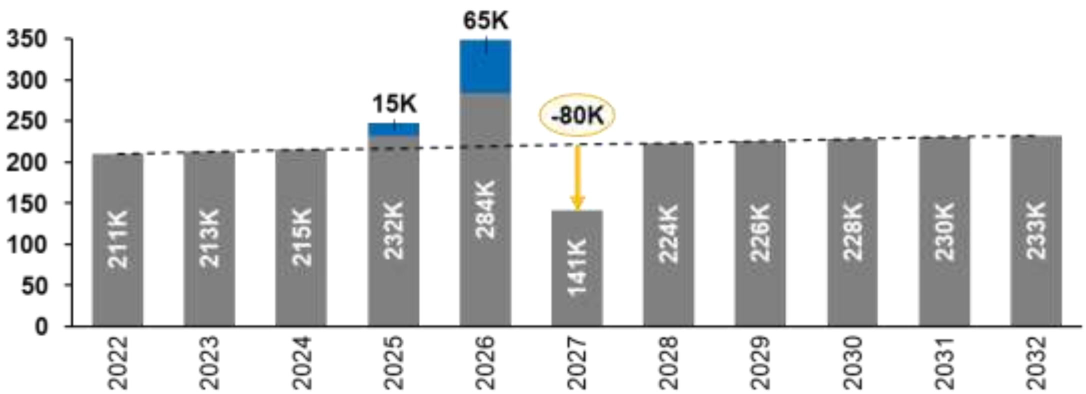
	2027 Regulations		2031 Regulations (Option 1 only)	
	2025	2026	2029	2030
Option 1	17,723	75,323	9,217	43,781
Option 2	15,291	64,988	-	-

Figure 2: Pre-buy Analysis

Pre-buy/ Low-buy Option 1



Pre-buy/ Low-buy Option 2



In addition to Ricardo's analysis, ACT has conducted its own detailed assessment of the pre-buy/no-buy response that likely would occur in the heavy-duty vehicle market in response to the per-vehicle cost increases associated with EPA's Option 1 proposal. A copy of ACT's report is attached hereto as **Exhibit D**. ACT has concluded that proposed Option 1 regulations would lead to the "largest ever" pre-buy/no-buy market response. The specific results of ACT's analysis are summarized in the following tables:

Table 2: 2025-2026 Pre-buy Size Estimates – Scenario 1, Ricardo Costs

	MY2027 $ Change Op. Costs	MY2027 % Change Op. Costs	Anticipated Prebuy: 2025	Share of new Market	Anticipated Pre-buy: 2026	Share of new Market	Combined 2025-2026 Pre-buy
US Class 8 Tractor	$ 30,414	14%	15,343	8%	65,026	36%	80,369
US Class 8 Vocational	$ 30,366	12%	4,916	8%	18,082	28%	22,998
US Total Class 8			20,259	8%	83,108	34%	103,367
US Classes 6-7	$ 14,290	14%	5,167	6%	24,472	22%	29,639
US Total Classes 6-8			**25,426**	**7%**	**107,580**	**25%**	**133,006**
Source: ACT Research Co.,LLC: Copyright 2022							

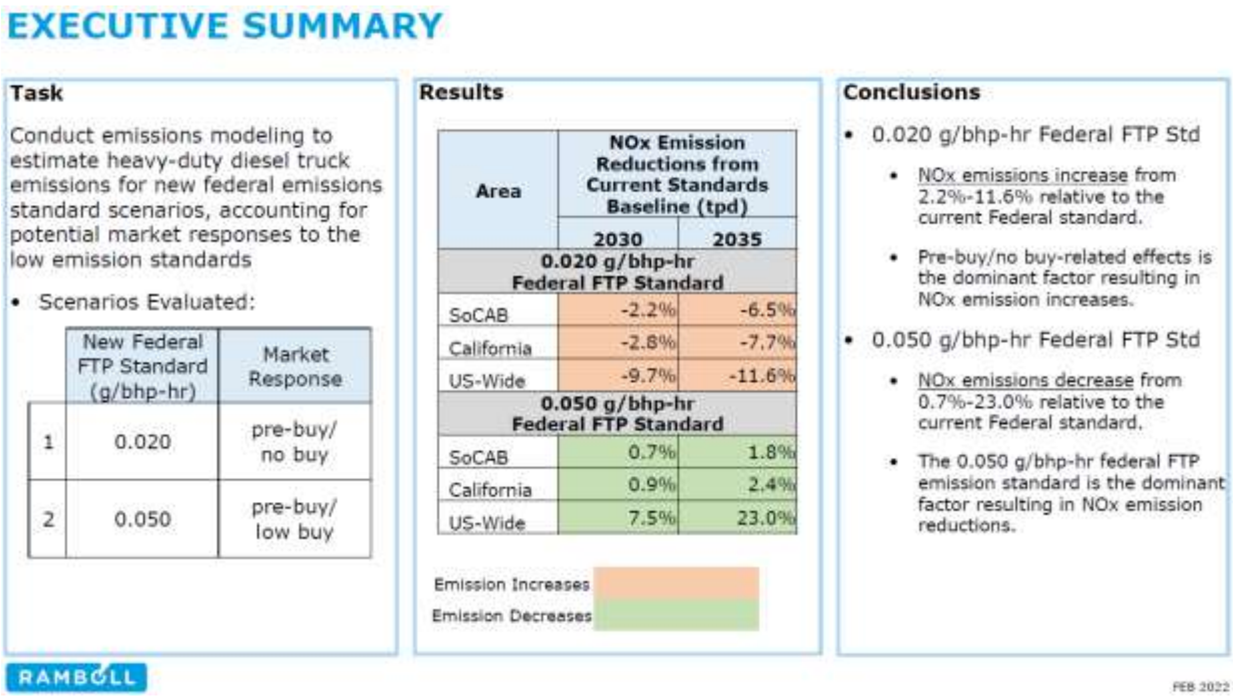
Table 3: 2029-2030 Pre-buy Size Estimates – Scenario 1, Ricardo Costs

	MY2031 $ Change Op. Costs	MY2031 % Change Op. Costs	Anticipated Pre-buy: 2029	Share of new Market	Anticipated Pre-buy: 2030	Share of new Market	Combined 2029-2030 Pre-buy
US Class 8 Tractor	$ 20,567	9%	6,744	4%	42,044	19%	48,789
US Class 8 Vocational	$ 20,493	7%	3,240	5%	12,451	17%	15,691
US Total Class 8			9,984	4%	54,496	19%	64,480
US Classes 6-7	$ 6,733	6%	2,837	3%	11,577	11%	14,414
US Total Classes 6-8			**12,821**	**4%**	**66,072**	**15%**	**78,894**
Source: ACT Research Co.,LLC: Copyright 2022							

Similar to what Ricardo has estimated, and by way of example, ACT estimates that the anticipated pre-buys of HHD vehicles in response to the implementation of Option 1 regulations and costs would impact more than 37% of the market in advance of the MY 2027, and an additional 19% of the market in advance of the MY 2031. The impact on the overall HD market would be an aggregate pre-buy of approximately 211,900 trucks. Thus, when factoring-in the likely actual pre-buy/no-buy impacts at issue, it is evident that EPA has understated the per-vehicle cost impacts of its proposed low-NO_x regulations, in part, due to the fact that the Agency has over-estimated the number of low-NO_x-compliant trucks that will be acquired in the years starting in 2027, and extending out through 2031 and beyond.

The market impacts from the expected pre-buy go beyond the number of impacted HD vehicles. Pre-buys also trigger subsequent low-buys or no-buys, which in turn can result in significant layoffs in the vehicle-manufacturing industry and in related market sectors as well. ACT's report analyses and quantifies those reasonably anticipated employment impacts, which, if the Option 1 standards are finalized, would be dramatic. More specifically, and as detailed in the ACT report, the likely layoffs resulting from the pre-buy/low-buy that the costs of the Option 1 requirements will trigger would amount to approximately 220,700 jobs in the aggregate. (See ACT Report, pp. 14-17.)

In addition, the reasonably anticipated pre-buy/no-buy response will substantially diminish the potential environmental benefits from a nationwide program centered around a 0.02 g/bhp-hr standard, as opposed to Option 2-like standards. In that regard, Ramboll has compared the relative efficacy, from a national NO_x emissions-inventory perspective, of a low-NO_x program based on a 0.02 g/bhp-hr standard, including the expected associated pre-buy/no-buy response, with a low-NO_x program based on a 0.05 g/bhp-hr standard, which Ramboll assumes would result in a 50% lower pre-buy/no-buy response and greater availability of new emissions-compliant HD vehicles. A copy of Ramboll's report is attached hereto as **Exhibit E**. The overall results of Ramboll's comparative inventory analysis are set forth below.



EXECUTIVE SUMMARY

Task

Conduct emissions modeling to estimate heavy-duty diesel truck emissions for new federal emissions standard scenarios, accounting for potential market responses to the low emission standards

- Scenarios Evaluated:

	New Federal FTP Standard (g/bhp-hr)	Market Response
1	0.020	pre-buy/ no buy
2	0.050	pre-buy/ low buy

Results

Area	NOx Emission Reductions from Current Standards Baseline (tpd)	
	2030	2035
0.020 g/bhp-hr Federal FTP Standard		
SoCAB	-2.2%	-6.5%
California	-2.8%	-7.7%
US-Wide	-9.7%	-11.6%
0.050 g/bhp-hr Federal FTP Standard		
SoCAB	0.7%	1.8%
California	0.9%	2.4%
US-Wide	7.5%	23.0%

Emission Increases

Emission Decreases

Conclusions

- 0.020 g/bhp-hr Federal FTP Std
  - NOx emissions increase from 2.2%-11.6% relative to the current Federal standard.
  - Pre-buy/no buy-related effects is the dominant factor resulting in NOx emission increases.
- 0.050 g/bhp-hr Federal FTP Std
  - NOx emissions decrease from 0.7%-23.0% relative to the current Federal standard.
  - The 0.050 g/bhp-hr federal FTP emission standard is the dominant factor resulting in NOx emission reductions.

RAMBOLL

FEB 2022

Ramboll's emissions-inventory analysis shows that an Option 2-like low-NO_x program targeting a 0.05 g/bhp-hr FTP/RMC NO_x standard would reduce baseline-projection NO_x emissions by approximately 23% as of 2035, while a program centered around a 0.02 g/bhp-hr NO_x standard could actually increase NO_x emissions from current baseline projections by as much as 11% as of 2035 due to the "largest-ever" pre-buy/no-buy response, and due to the projected unavailability of new HDOH diesel vehicles and engines that would be fully-compliant with the associated Option 1 low- NO_x requirements. Thus, Ramboll's analysis helps to confirm the enhanced efficacy of EMA's more feasible alternative proposal.

e. NERA's analysis clearly establishes the relevant health benefits benchmark for the Low-NO_x Rulemaking

Turning to the potential health-related benefits from EPA's proposal, NERA's expert reports (**Exhibit "C"** hereto) estimate and quantify those potential benefits. In that regard, NERA conducted a prior "scoping study" to delineate the potential quantitative benefits from the types of low-NO_x regulations at issue, and, as a supplement to that, NERA also has prepared a critical review of the portions of the RIA that include the Agency's quantitative risk assessment.

NERA's earlier "scoping study" includes two parts: a conceptual summary of methods and results; and a more detailed technical analysis. As explained in its conceptual summary, NERA conducted a comprehensive "scoping" analysis to estimate, on a per-vehicle basis, the likely maximum range of monetized health benefits that could result over time from the implementation of the envisioned low-NO_x standards. The relevant findings and conclusions from NERA's report as they relate to the monetized benefits potentially attributable to reductions in NO_x-related secondary $PM_{2.5}$ and ozone are described below.

NERA focused its benefits calculations on the value of projected health-risk reductions from the projected reductions in ambient ozone and secondary $PM_{2.5}$ that could result from reduced HDOH truck NO_x emissions due to the implementation of substantially tighter HDOH NO_x standards. Based on a long history of such benefits calculations (by EPA and many other entities), NERA assumed that approximately 98% of the estimated health benefits from reductions in ozone and $PM_{2.5}$ would be due to reductions in mortality risks. Thus, NERA focused its benefit-per-truck estimates by estimating only mortality risk benefits, having confidence that this method would have no meaningful impact on any quantified conclusions.

In order to obtain per-truck benefit estimates, NERA first calculated the tons of NO_x emissions reductions from an average new truck that would be purchased in 2027 meeting the tighter low-NO_x standard, accounting for a potential truck-life of up to 30 years. NERA made that calculation for each of the 8 truck types covered by the assumed low-NO_x standards. That computation was carried forward for each year of a truck's operational life. NERA also assessed the average truck's continued operation in each future year based on truck survival rates over time. The emissions reductions in each future year were then translated into a dollar estimate of each year's health benefits using a "reduced form" method in which the precursor emissions changes were multiplied by a "benefit per ton" value.

NERA's methodology generated a time-line from 2027 through 2057 of annual benefits per-truck in each year of the average 2027-vintage truck's operating life, varying across time (generally declining) as the truck ages. NERA discounted that stream of benefits to obtain the present value of benefits per-truck for each of the 8 truck types. Those 8 values were then combined into a single sales-weighted average benefit-per-truck estimate.

The most important input to NERA's benefit-per-ton estimates, and hence the benefit-per-truck estimates, is the assumption about the increase in mortality risk per unit change (reduction) in ozone and secondary $PM_{2.5}$ concentrations. That assumption is usually based on a statistically-derived association between mortality risk and observed pollutant concentrations or exposures, called a concentration-response (C-R) coefficient. The assumed C-R coefficient typically is derived from one or more of many existing epidemiological studies and associated peer-reviewed papers. EPA tends to change the mortality risk assumption as new epidemiology papers are published and as each NAAQS-review cycle is conducted. NERA reviewed statements in EPA's Policy Assessments for $PM_{2.5}$ and ozone (EPA, 2020 and 2019b) to attempt to anticipate which assumptions EPA might ultimately adopt in the RIA for its rulemaking. Without commenting on the appropriateness of any such studies, NERA decided it would be reasonable to provide a range of estimates for the secondary $PM_{2.5}$ benefits-per-ton at issue. The lower end of the range is based on a C-R coefficient for all-cause mortality risk derived from the Krewski et al. (2009) study, and the higher end of the range is based on a C-R coefficient estimate for all-cause mortality risk from the Di et al. (2017) study.

There are significant scientific uncertainties when using statistical associations from epidemiological studies to predict risks for different populations and under different air quality concentrations and conditions in the future. At the same time, there are methods for identifying how the uncertainties may be reduced or scaled to derive benefits estimates that have a higher degree of confidence.

More specifically, any use of the derived unit risk estimate from an epidemiology study to predict changes in risks in different locations and under different levels of ambient pollution exposure necessarily involves extrapolation outside of the original range of the study's data. Extrapolation always introduces uncertainties that are not included in any of the original study's statistical measures of confidence. The more extreme is the extrapolation that a risk analysis requires with respect to exposure and population conditions not representative of the original study, the less qualitative confidence one would have in the derived risk estimate.

Such extrapolation can be a particular problem when using studies of associations between ambient air pollutant and health outcomes, even from the relatively recent past, to predict risk in a future year because of the steady declines in ambient pollutant concentrations that have taken place, especially with respect to $PM_{2.5}$, and that are projected to continue in the future. For example, the average concentrations of $PM_{2.5}$ experienced by the individuals studied in Krewski et al. (2009) fell by 30% during the period from 1980 to 2000, over which their mortality risk levels were being observed. Furthermore, the EPA dataset that NERA used to project average $PM_{2.5}$ levels in 2035 are another 50% lower (before any reductions due to a tightened HDOH low-NO_x standard) than the average exposures occurring at the end of the Krewski et al. study period (i.e., in 2000). Thus, the uncertainties due to extrapolation issues in this case are significant. Yet EPA did not take them into account at all.

It is possible to adjust the calculated risk estimates from the relevant epidemiology studies to exclude the portions of the estimates that involve the most extreme amounts of extrapolation from the exposure levels at issue in the original studies. As the amount of extrapolation from the original exposure and health-benefits estimates is reduced, confidence in the resulting estimate is qualitatively improved. This creates a "sliding-scale" of benefits estimates from least confident to most confident.

EPA introduced such a sliding confidence scale for its $PM_{2.5}$ co-benefits estimates in a recent RIA (EPA, 2019a), which employed a health risk estimate for all-cause mortality from the Krewski et al. (2009) epidemiology study. On that sliding scale, the "more confident" end of the spectrum of mortality risk estimates was calculated by excluding those portions of the underlying exposure and risk calculations that applied the original study's risk factor to $PM_{2.5}$ pollutant exposures below the 25^{th} percentile of the originally-observed range of $PM_{2.5}$ exposures. The 25^{th} percentile of a data set is generally viewed as the point where sparseness of exposure observations begins to undercut the ability to determine if an average C-R slope detected over the entire set of originally-observed exposure levels still remains at those lower and less frequently experienced exposure levels.

NERA applied that sliding-scale approach in the calculation of benefits that could be ascribed to the type of HDOH low-NO_x standards at issue. In doing so, by requiring more confidence in the benefit-per-truck estimates, the estimates declined somewhat, since they exclude benefits that are in areas with projected baseline $PM_{2.5}$ concentrations that are below various percentile levels of the pollutant observations in the original study (e.g., below the 25^{th} percentile of exposures).

There is no way to select a single "best" cut-off point for limiting extrapolation uncertainties. In its last $PM_{2.5}$ NAAQS decision (i.e., the 2013 rulemaking), the EPA Administrator discussed how insufficient confidence in the continued existence of health risk associations would arise somewhere between the 10th to 25th percentiles of a study's range of observations. She chose to set the standard near the lowest of the 25th percentiles of available studies. NERA made an even more conservative choice in its analysis in this instance, and set its "best estimate" values at the 10th-percentile cut-off point of exposures from the underlying epidemiological studies.

In addition, in recognition of the significant differences in the projected $PM_{2.5}$ concentration distributions that exist between California and the rest of the country, NERA recomputed its benefits-per-truck for California and for the "Rest of the U.S.," separately. NERA's results, including the effects of the sliding-scale confidence-adjustments, are provided for $PM_{2.5}$ in Tables 4 and 5 of NERA's Report, which are reproduced below:

Table 4: Geographically Disaggregated $PM_{2.5}$ Benefit-Per-Truck Estimates (2019$) by Confidence Level and Discount Rate (Range Reported for Each Confidence Level Is Based on Low and High C-R Estimates from Di *et al.*, 2017)

	No Adjustment	LML and Above	1st Percentile and Above	5th Percentile and Above	10th Percentile and Above	25th Percentile and Above
3% Discount Rate						
California	$9,330-$12,700	$9,330-$12,700	$9,330-$12,700	$8,870-$12,080	$7,880-$10,730	$5,570-$7,580
Rest of U.S.	$4,260-$5,810	$4,260-$5,810	$4,260-$5,810	$3,510-$4,780	$2,190-$2,990	$180-$250
National	$4,650-$6,340	$4,650-$6,340	$4,650-$6,340	$3,930-$5,360	$2,670-$3,640	$650-$890
7% Discount Rate						
California	$6,820-$9,290	$6,820-$9,290	$6,820-$9,290	$6,490-$8,840	$5,760-$7,850	$4,070-$5,550
Rest of U.S.	$3,180-$4,330	$3,180-$4,330	$3,180-$4,330	$2,620-$3,560	$1,640-$2,230	$130-$180
National	$3,460-$4,710	$3,460-$4,710	$3,460-$4,710	$2,930-$3,980	$1,980-$2,700	$490-$660

LML = Lowest Measured Level, meaning the minimum observed $PM_{2.5}$ concentration in the original epidemiological study

Table 5: Geographically Disaggregated Ozone Benefit-Per-Truck Estimates (2019$) by Confidence Level and Discount Rate (Range Reported for Each Confidence Level Is Based on Low and High C-R Estimates Zanobetti and Schwartz, 2008)

	No Adjustment	LML and Above	1st Percentile and Above	5th Percentile and Above	10th Percentile and Above	25th Percentile and Above
3% Discount Rate						
California	$2,920-$4,480	$2,920-$4,480	$2,920-$4,480	$2,920-$4,480	$2,560-$3,920	$1,690-$2,600
Rest of U.S.	$250-$390	$250-$390	$250-$390	$250-$390	$190-$300	$80-$130
National	$530-$810	$530-$810	$530-$810	$530-$810	$440-$670	$250-$380
7% Discount Rate						
California	$2,140-$3,280	$2,140-$3,280	$2,140-$3,280	$2,140-$3,280	$1,870-$2,870	$1,240-$1,900
Rest of U.S.	$190-$290	$190-$290	$190-$290	$190-$290	$150-$220	$60-$90
National	$390-$590	$390-$590	$390-$590	$390-$590	$320-$490	$180-$280

LML = Lowest Measured Level, meaning the minimum observed ozone concentration in the original epidemiological study

It should be noted that the benefits estimates in NERA's scoping study reports are conservative or, stated differently, weighted to the high side. That conservative approach stems from the fact that in conducting its analyses, NERA assumed, among other things, that: there is no exposure threshold to $PM_{2.5}$ or ozone below which mortality effects are no longer evident; the slope of the relative risk function for mortality is linear all the way down to zero exposure; and (as noted) it is appropriate to assess quantified benefits values at the 10th percentile of the exposure levels at issue in the underlying epidemiological studies, as opposed to utilizing a cut-point at the 25th percentile of exposures. Applying different assumptions regarding any of the foregoing points would lead to a reduction in the calculated benefits estimates. (NERA Report pp. 3-6, 9, 11, and 14-15.)

As noted earlier, if confidence-adjusted values are not used, the potential benefits from the Agency's low-NO_x proposal could be as high as approximately $4,500 per vehicle. On the other hand, based on NERA's confidence-adjusted analysis, and excluding only up to the 10th-percentile of the exposure data from the underlying epidemiology studies, and also applying a 3% discount rate as opposed to a 7% discount rate, the national per-truck benefits that could be derived from the types of HDOH low-NO_x regulations at issue range from approximately $4,300 on the high-side to $3,100 on the low-side, for an average per-truck benefit of $3,700. Comparing that confidence-adjusted average per-truck benefit against the average per-HHD-truck cost as determined by Ricardo ($42,000) yields a costs-to-benefits ratio for HHD trucks (or a negative benefits-to-costs ratio) of approximately 10:1, which indicates that the proposed regulations, if not revised, will be cost-prohibitive.

More recently, as a follow-up to its scoping study, NERA has conducted a critical review of the Agency's methodology for estimating the potential quantitative health benefits associated with the rulemaking proposal at issue, as spelled out in the Agency's RIA. A copy of NERA's technical comments on the Agency's benefits estimates is included in **Exhibit "C."**

NERA's detailed critique demonstrates that EPA's RIA has a number of significant methodological flaws leading to a significant over-estimation of potential health-related benefits. The principal methodological flaws in the Agency's estimation of benefits include the following:

(i) EPA has elected to base its estimates of ozone-related mortality risks on a 2016 study by Turner, *et al.* that derived an unrealistic C-R factor for chronic ozone exposures. As a consequence of its unreasonable reliance on the Turner, *et al.* C-R factor, EPA has estimated high-end mortality ozone risks that are higher than the estimated mortality risks for $PM_{2.5}$, a result that is completely at odds with the established scientific consensus regarding the relative magnitude of the potential mortality risks associated with $PM_{2.5}$ exposures. As NERA explains, "risk estimates for ozone-related respiratory mortality using the Tuner, *et al.* (2016) study are theoretically and technically unreliable." (NERA Critique, p. 22.)

(ii) The Turner, *et al.* (2016) study is flawed principally because it: applies an incorrect exposure window to the underlying data set, thereby underestimating exposures (which biases risks upward); applies a year-round exposure metric, as opposed to an ozone-season metric; and fails to account for the threshold of effects for long-term mortality that emerged from the underlying data, which threshold for ozone was approximately 56 ppb. The net result from that flawed analyses is the derivation of a risk ratio for ozone mortality that "has completely upended the long-established history of multi-pollutant air quality benefits assessments in which ozone mortality benefits are substantially smaller than $PM_{2.5}$ benefits.” (NERA Critique, pp. 6, 14.) Accordingly, NERA assigns “zero reliability to estimates based on the Turner, *et al.* C-Rs” (id at p. 13), and concludes that the study “should be removed from the benefits analysis” (Id. at pp. 9, 17.) NERA further recommends that EPA should “omit long-term respiratory mortality from the Draft RIA altogether.” (NERA Critique, p. 13.)

(iii) Significantly, the Agency’s RIA is at odds with the Agency’s own 2020 NAAQS review process where the Agency-drafted Integrated Science Assessment (ISA) found inconsistent associations between ozone and respiratory mortality, did not ascribe confidence in any quantitative estimates of ozone respiratory risks, and so included no quantitative estimates of such risks. (See also NERA Critique, pp. 10-13.) Thus, the Agency – the same Agency that has issued the draft RIA for this rulemaking – has expressly concluded that the evidence is suggestive of, but not sufficient to infer, a causal relationship between long-term ozone exposure and cardiovascular effects, respiratory mortality or total mortality. (See ISA, Tables 4-2 and 6-2, pp. 4-65, 6-30, 6-43), and has specifically stated (citing the Tuner study) that there is “little evidence for an association between long-term exposure and total mortality.” (ISA, p. 6-28.)

Importantly, the scientific consensus on that point has not changed. Indeed, very recently, on April 29, 2022, and as a part of the pending reconsideration of the 2020 NAAQS, EPA issued a review draft of its Policy Assessment (PA) for ozone. In that PA, EPA specifically concludes that the newer available studies “do not materially change the findings of the 2020 ISA or warrant reopening of the air quality criteria” for ozone. (See EPA Staff Presentation to CASAC, slide 6, April 29, 2022.) Significantly, in that just-released PA for ozone, EPA chose not to rely on Turner, *et al.* (2016), noting that the “air quality data are not described [in the PA/ISA] for that study as it relied on estimated O_3 concentrations for the years 2002-2004 as surrogates for study population O_3 concentrations during the 1982-2004 period.” (See PA, p. 3B-33.) (See also NERA Critique, pp. 10-11.) Thus, the EPA staff with the greatest expertise in this area have actually agreed with NERA that the Turner, *et al.* (2016) study relies on an incorrect exposure window, and so should not be used to derive C-Rs. EPA’s draft RIA flies in the face of its own more robust scientific conclusions, and so is patently unreasonable.

(iv) The Agency has failed to provide for any confidence-weighting to its benefits estimates. That has led to highly overestimated benefits due to the inherent unsupported assumption that the derived C-R relationships continue to hold fully, well below the ranges of exposure observations on which those C-R relationships were based. (NERA Critique, pp. 2-3.) When appropriate confidence-weighting factors are applied, it is clear that the Agency’s RIA has substantially over-estimated the health-related benefits at issue, most likely by more than an order of magnitude. (Id., Tables 1 and 2, pp 2-3, 18-30.)

In light of the foregoing, the Agency will need to revise its RIA and benefits estimates, and make the necessary changes to the resultant cost-benefit calculations before finalizing this rulemaking. As it stands, it remains clear that the Agency's Option 1 proposal is cost-prohibitive.

17. EPA Needs to Revise Its Proposal Regarding Confidentiality Determinations

EPA is proposing "to take a comprehensive approach for making confidentiality determinations related to the compliance information that companies submit to EPA." (87 FR at 17426.) More specifically, the Agency is proposing to make a series of categorical determinations that certain types of submitted compliance information will not be treated as confidential business information. The Agency also is proposing to maintain "the 40 CFR part 2" case-by-case process for making CBI determinations for all other submitted information not covered by the proposed categorial determinations of non-confidentiality.

EPA has categorized the types of emissions data that will be deemed subject to public disclosure, as follows:

(1) **Certification and compliance information**, which includes models and parts information, family determinants, general emission control systems information, and certificate request/requestor information;

(2) **Fleet value information**, which includes offsets, displacements, useful life, power payload tons, load factor, integrated work cycle, cycle conversion factors and test cycle, source classification, averaging set, intended application, and advanced technology ("AT") factors;

(3) **Source family information**, which includes engine family information, vehicle family information, subfamily name, engine family designation, and test group information;

(4) **Test information and results**, which include information collected during the certification process, PLT testing, in-use testing programs, and testing performed during an SEA, and which covers the actual test results themselves and the information necessary to understand those results and how the testing was conducted (including adjustments, modifications, maintenance, service hours, and detailed information regarding the recruitment and testing of in-use vehicles);

(5) **Averaging, banking, and trading ("ABT") credit information**, including banked credits, transferred credits, total credits, credit balance, and annual credit balance;

(6) **Production volume information**, which includes the total number of engines, vehicles or equipment produced;

(7) **Defect and recall information**, which includes any reported emissions data and an estimate of the defect's impacts on emissions, and the relevant information collected under the standard-setting parts, but not including the "defect investigation report;" and

(8) **Selective enforcement audit ("SEA") compliance information**, which includes family name, when and where the SEA was conducted, the number of tests conducted, test article details, how the engines were shipped and stored, and test results.

(See 87 FR at pp. 17611-17618.)

The Agency's proposal also lists a number of information categories where the confidentiality determination will continue to be made on a 40 CRR Part 2 case-by-case basis, as is the current practice. EPA describes those categories of emissions-data information, as follows:

(1) projected production and sales,

(2) production start and end dates outside of the defect and recall context,

(3) specific and detailed descriptions of the emissions control operation and function,

(4) design specifications related to aftertreatment devices,

(5) specific and detailed descriptions of auxiliary emission control devices (AECDs),

(6) plans for meeting regulatory requirements (e.g., ABT pre-production plans),

(7) procedures to determine deterioration factors and other emission adjustment factors and any information used to justify those procedures,

(8) financial information related to ABT credit transactions (including dollar amount, parties to the transaction and contract information involved) and manufacturer bond provisions (including aggregate U.S. asset holdings, financial details regarding specific assets, whether the manufacturer or importer obtains a bond, and copies of bond policies),

(9) serial numbers or other information to identify specific engines or equipment selected for testing,

(10) procedures that apply based on the manufacturers request to test engines or equipment differently than we specify in the applicable standard-setting parts,

(11) information related to testing vanadium catalysts in 40 CFR part 1065, subpart L (proposed in the NPRM),

(12) GPS data identifying the location and route for in-use emission testing,

(13) defect investigation reports — The information contained in defect investigation reports may encompass both emission data and information that may be CBI, so EPA is not proposing a determination for this report as whole. Instead, procedurally the Agency will treat those reports in accordance with the existing case-by-case determination process — and

(14) comments submitted in the "comment field" of EPA's compliance reporting software.

(See 87 FR at p. 17619.)

EMA has a number of concerns regarding the Agency's proposal for making generalized CBI determinations going forward. More specifically, a number of the broad categories of submitted information that the Agency proposes to treat generally as non-confidential do, in fact, include CBI that warrants protection from public disclosure.

The Agency's proposed rationale for making such broad and general a priori CBI/non-CBI determinations seems to stem from the workload that the Agency needs to undertake to ensure that FOIA requests do not sweep-up or otherwise compromise CBI. But a desire to reduce the Agency's workload is not a sufficient basis to violate manufacturer's trade secret rights, including under the Uniform Trade Secrets Act. Moreover, to the extent that EPA acts to remove the current presumptive protections for manufacturers' CBI claims, the Agency actually will incentivize more, not fewer, FOIA requests, as competitors would be spurred-on to discover all that they could about other OEM's products and processes, an outcome that could have grave consequences for the industry.

In light of the foregoing, the Agency will need to revise its proposed categorical determinations accordingly. Set forth below is a chart that delineates EMA's concerns in this regard.

LN Item	Section	Comment	Text	EMA comments
1	§ 1068.11(a)(1)	This paragraph (a) applies the definition of ''Emission data'' in 40 CFR 2.301(a) for information related to engines/equipment subject to this part. ''Emission data'' cannot be treated as confidential business information and shall be available to be disclosed to the public except as specified in § 1068.10(d)(1). The following categories of information qualify as emission data, except as specified in paragraph (c) of this section:	**1. Certification and compliance information**, which includes models and parts information, family determinants, general emission control systems information, and certificate request/requestor information;	Except for the certificate requestor, all of this information is released with a Certificate of Conformity.
2	§ 1068.11(a)(2)	Proposed categorization as non-confidential information	**2. Fleet value information**, which includes offsets, displacements, useful life, power payload tons, load factor, integrated work cycle, cycle conversion factors and test cycle, source classification, averaging set, intended application, and advanced technology ("AT") factors;	All of this is public information.
3	§ 1068.11(a)(3)	Proposed categorization as non-confidential information	**3. Source family information**, which includes engine family information,	All of this is public information.

			vehicle family information, subfamily name, engine family designation, and test group information;	
4	§ 1068.11(a)(4)	Proposed categorization as non-confidential information. Instead, should be handled on case-by-case basis.	**4. Test information and results**, which include information collected during the certification process, PLT testing, in-use testing programs, and testing performed during an SEA, and which covers the actual test results themselves and the information necessary to understand those results and how the testing was conducted (including adjustments, modifications, maintenance, service hours, and detailed information regarding the recruitment and testing of in-use vehicles);	This category includes very competitive CBI.
5	§ 1068.11(a)(5)	Proposed categorization as non-confidential information. Instead, should be handled on case-by-case basis.	**5. Averaging, banking, and trading ("ABT") credit information**, including banked credits, transferred credits, total credits, credit balance, and annual credit balance;	This category includes very competitive CBI
6	§ 1068.11(a)(6)	Proposed categorization as non-confidential information. Instead, should be handled on case-by-case basis.	**6. Production volume information**, which includes the total number of engines, vehicles or equipment produced;	For HDOH engines, this information is released after the end of the model year. Before then, projections should remain CBI. In addition, other engine-product sectors do not disclose production volumes, and that information from those other engine-product sectors should remain CBI.
7	§ 1068.11(a)(7)	Proposed categorization as non-confidential information. Instead, should be handled on case-by-case basis.	**7. Defect and recall information**, which includes any reported emissions data and an estimate of the defect's impacts on emissions, and the relevant information collected under the standard-setting parts, but not including the "defect investigation report;" and	Emissions data are competitive CBI.
7	§ 1068.11(a)(8)	Proposed categorization as non-confidential information. Instead, should be handled on case-by-case basis.	**8. Selective enforcement audit ("SEA") compliance information**, which includes family name, when and where the SEA was conducted, the number of tests conducted, test article details, how the engines were shipped and stored, and test results.	Test results are competitive CBI.

	§ 1068.11(b)(1)	(b) The following categories of information are not eligible for confidential treatment, except as specified in § 1068.10(d)(1): (d) If you submit information that is not addressed in paragraphs (a) through (c) of this section, you may claim the information as confidential. We may require you to provide us with information to substantiate your claims. If claimed, we may consider this substantiating information to be confidential to the same degree as the information for which you are requesting confidential treatment. We will make our determination based on your statements to us, the supporting information you send us, and any other available information. However, we may determine that your information is not subject to confidential treatment consistent with 40 CFR part 2 and 5 U.S.C. 552(b)(4).	Published information, including information that is made available in annual and quarterly filings submitted to the U.S. Securities and Exchanges Commission, on company websites, or otherwise made publicly available by the other submitter.	EMA agrees.
	§ 1068.11(b)(2) and § 1068.11(c)(1)	Not confidential information. The following categories of information are subject to the process for confidentiality determinations in 40 CFR part 2, as described in 40 CFR 2.301(j)(5).	Observable information available to the public after the introduction to commerce date. (1)Projected sales and production volumes.	EMA agrees. Projected numbers should remain CBI.
	§ 1068.11(c)(2)	May ask for CBI	(2)Production start and end dates.	EMA agrees. Production dates could be competitive.
	§ 1068.11(c)(3)	May ask for CBI	(3) Detailed description of emission control operation and function.	Highly competitive CBI.
	§ 1068.11(c)(4)	May ask for CBI	(4) Design specifications related to aftertreatment devices.	Highly competitive CBI.
	§ 1068.11(c)(5)	May ask for CBI	(5)Description of auxiliary emission control devices (AECDs).	These strategies are highly sensitive CBI.
	§ 1068.11(c)(6)	May ask for CBI	(6) Plans for meeting regulatory requirements. For example, this applies for any projections of emission credits for the coming model year or determinations of the number of required repair facilities that are based on projected production volumes.	Plans should always remain CBI.
	§ 1068.11(c)(7)	May ask for CBI	(7) The following information related to deterioration factors and other adjustment factors: (i) Procedures to determine deterioration factors and	Emissions data are competitive CBI.

			other emission adjustment factors. (ii)Any information used to justify those procedures. (iii)Emission measurements you use to compare procedures or demonstrate that the procedures are appropriate.	
	§ 1068.11(c)(8)	May ask for CBI	(8) Financial information related to the following items: (i)ABT credit transactions, including dollar amount, identity of parties, and contract information. (ii)Meeting bond requirements, including aggregate U.S. asset holdings, financial details regarding specific assets, whether the manufacturer or importer obtains a bond, and copies of bond policies.	Financial information relating to ABT is CBI.
	§ 1068.11(c)(9)	May ask for CBI	(9) Serial numbers or other information to identify specific engines or equipment selected for testing.	EMA agrees.
	§ 1068.11(c)(10)	May ask for CBI	(10)Procedures that apply based on your request to test engines/equipment differently than we specify in the regulation. This applies for special and alternative test procedures. This also applies, for example, if we approve a broader or narrower zone of engine operation for not-to-exceed testing.	Emissions testing protocols outside the prescribed regulations can be competitive CBI.
	§ 1068.11(c)(11)	May ask for CBI	(11) Information related to testing vanadium catalysts in 40 CFR part 1065, subpart L.	EMA agrees.
	§ 1068.11(c)(12)	May ask for CBI	(12) GPS data identifying the location for in-use emission measurements.	Route information can be very competitive CBI.
	§ 1068.11(c)(13)	May ask for CBI	(13) Information related to possible defects that are subject to further investigation (not confirmed defects).	During the investigative phase these should remain CBI.

EPA should revise its proposal regarding future confidentiality determinations in a manner consistent with the foregoing highlighted concerns.

18. EPA Has Not Completed the Research and Analysis Required for this Rulemaking

EPA's "Clean Trucks Plan" is a rulemaking that will significantly impact all of the core elements of EPA's HDOH diesel-emissions control program. The NPRM proposes sweeping changes to those core regulatory program components, including up to a 90% reduction of the applicable NO_x standard, reopened reductions to the Phase 2 CO_2 emissions standards, an entirely new certification test procedure targeting operating modes never-before regulated, and a completely overhauled in-use emissions protocol, which requires a careful analysis of PEMS-based (and OBD) in-use measurement capabilities and procedures. The Agency is proposing this suite of new technical requirements while also proposing to nearly double the mileage over which compliance will be required. In that regard, the extended Useful Life requirements will very likely compel replacement of major emissions control systems costing well over $10,000 within the required compliance period. On top of that, the significant direct and indirect costs that are to be borne by the trucking industry, and thereby consumers, to meet those new UL standards will be impacted even more by the additional costs associated with the proposed 6-fold increase in the required emission warranties.

Such a massive regulatory undertaking, with cost implications many times over any prior rulemaking directed at the heavy-duty engine and vehicle industry, should be supported by extensive research and analysis to prove-out and justify the very considerable expenses and burdens that will fall upon manufacturers and the public. Unfortunately, that is not the case here. To the contrary, there are many underlying research activities that are still underway, some which likely will not be completed by the time the rule is finalized, let alone when it was proposed, and there are other major gaps in the overall research effort that will not be filled at all. Several examples of these incomplete or omitted research projects include the following:

- The feasibility demonstration of the Stage 3 technology package that EPA proposes as justification for the proposed standards was incomplete when EPA drafted the requirements included in the NPRM. The initial 800,000-mile test results became available well after EPA staff had drafted the NPRM.

- Dissatisfied that the results from the Stage 3 aging tests show multiple instances of non-compliance to the proposed standards, EPA has initiated testing of an "improved" technology package simultaneous with the release of the NPRM, with the hope of improving long-term emissions stability and reducing the significant increases in N_2O emissions measured on the first attempt (N_2O, has a 100-year scale global warming potential of 265 to 298.) Testing and aging of this new "System A" prototype is expected to extend out through October 2022, after the time EPA will be obliged to finalize this rulemaking so it can move on to inter-agency review, all in accordance with the Agency's self-imposed year-end deadline for a published final rule.

- Industry-funded testing of the EPA Stage 3 prototype technology package to understand tailpipe NO_x sensitivity to sensor variabilities and cold weather operation will not be conducted until May or June of this year. The analyses of those data will require additional time. Without those industry-funded test results, there will be *no* assessment of those critical variabilities, which represent only a subset of the factors that "stack-up" into the compliance margin that manufacturers will need, but that EPA has yet to account for in this rulemaking process.

- The PEMS measurement variability study, involving extensive testing, modeling, analysis, and verification, is incomplete. SwRI anticipates completing that work, which also will be supported through on-road validation testing by UC Riverside (CE-CERT), by the end of August 2022, likely just weeks before EPA will be obliged to finalize this rulemaking according to the Agency's internal self-imposed schedule.

- The Coordinating Research Council (not EPA) is evaluating the influence that diesel fuel variables, as wells as varieties of renewable diesel and biodiesel fuels, have on tailpipe NO_x emissions from the Stage 3 low-NO_x technology EPA is relying on in this rulemaking. That testing is scheduled to be completed in May or June, with follow-on data analysis thereafter. Additional testing to understand long-term effects of operation on biofuels has yet to be planned, but should be very informative to the setting of standards as well, given EPA's new requirements for compliance using "any commercially available" biodiesel fuel meeting the current inadequate ASTM specifications. EPA has formulated its proposal without any of those fuels-impacts data.

All of the critical research outlined above was not available or not completed in time to support the pending NPRM. Indeed, the vital research at issue is still in process, with much of it expected to be delivered just as the proposed rule is expected to "go final" in the fall, all to meet EPA's goal of having the new low-NO_x standards take effect in 2027. Thus, there is considerable risk that these critical data will be *unavailable* when these largely infeasible standards are to be finalized.

Perhaps even more concerning are the necessary data-generation projects that are completely *unplanned* at this time. More specifically, EPA intends to complete this rulemaking without having access to the following:

- Durability testing to determine whether cylinder deactivation (CDA) is a viable technology suitable for the rigorous demands of heavy-heavy-duty engines, or to determine whether it should be expected that NVH concerns can be managed over the broad and diverse range of products and applications unique to the commercial truck industry, or to assess if CDA is capable of lasting 800,000 miles without a major service intervention. CDA is a cornerstone technology for EPA's technical feasibility demonstration, critical to meeting the low-load NO_x emission requirements that are a focus for this rulemaking. Yet no data regarding the feasibility of CDA in this context will be in the rulemaking record.

- In-vehicle in-use testing of the Stage 3 low-NO_x technology system, to understand if emissions compliance is really achievable over the full range of real-world ambient conditions and operating cycles covered under the completely revamped 3B-MAW in-use test requirements, and to see if the new multi-component system can even fit into the broad array of impacted trucks, will not be done. The rulemaking record will have no data from any vehicle equipped with a Stage 3-type engine system.

- It appears that EPA will not undertake any effort to resolve the considerable discrepancy between the Agency's cost estimates and those of NREL and Ricardo. Cost impacts are extremely important to justifying the many onerous requirements included in this rulemaking. Further, there has been no effort to understand the benefits/cost ratio of any of the individual elements of this multi-faceted rulemaking package, such as whether the extended warranty requirements will yield emissions benefits commensurate with the very considerable costs to be incurred by customers.

Until all of the foregoing research needs are met in a comprehensive and credible manner, the record supporting the Agency's rulemaking will be at risk of being deemed incomplete and insufficient. This is a fundamental problem that will require collaboration to resolve. Falling that, this is a problem that could preclude the implementation of a final rule on the timeline that EPA is trying to maintain.

19. <u>Conclusions</u>

EMA shares broad agreement with the Agency on all of the core concepts of the proposed regulations. EMA's comments are therefore directed at the margins of EPA's proposal, particularly with respect to Option 1, not at the NPRM's core objectives. To that end, EMA has offered detailed recommended revisions, along with a more over-arching recommendation that the proposed regulations should be centered around revised Option 2-like requirements to enhance the feasibility and cost-effectiveness of the Agency's proposal. The changes that EMA recommends are not material from an overall emissions inventory perspective, but are vitally important to the finalization of a fully implementable low-NO_x rulemaking that can serve as a cost-effective bridge to a ZEV-truck future.

The stakes of this rulemaking are very high. Indeed, if EPA were to finalize its proposed Option 1, that would, as a practical matter, preclude the production and sale of HD diesel engines starting in 2027. OEMs cannot and so will not be able to build Option 1-compliant products. Such an unacceptable outcome from this rulemaking must be avoided. EMA is ready to work with the Agency to fashion the necessary revisions that will lead to the finalization, adoption and implementation of the fully optimized low-NO_x program for new HDOH engines and vehicles that all stakeholders are seeking.

Respectfully Submitted,

TRUCK AND ENGINE
MANUFACTURERS ASSOCIATION