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Docket Management Facility, M–30
U.S. Department of Transportation
West Building, Ground Floor, Room W12–140
1200 New Jersey Avenue, SE
Washington, DC 20590

Subject: Comments in Response to Notice of Intent to Prepare an Environmental Impact Statement for New Medium- and Heavy-Duty Fuel Efficiency Improvement Program (Docket No. NHTSA–2014-0074)

Dear Sir or Madam,

Enclosed are comments from Cummins Inc. regarding the above-referenced notice. We thank you for this opportunity to provide our comments. If you have any questions, please contact Matt Psota at matthew.psota@cummins.com.

Sincerely,

Brian Mormino
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Introduction

The National Highway Traffic Safety Administration (NHTSA), along with Environmental Protection Agency (EPA), are preparing alternatives for analysis in setting Phase 2 fuel efficiency and greenhouse gas (GHG) standards for medium- and heavy-duty on-highway vehicles and work trucks ("commercial vehicles"). Cummins Inc. ("Cummins") designs, manufactures, distributes and services engines and related technologies applied in these vehicles affected by the fuel efficiency and GHG standards and supports the government's efforts to develop the next phase of requirements. Cummins is an advocate for consistent and responsible regulations, including an aligned national program for GHG and fuel efficiency for medium- and heavy-duty engines and vehicles. To that end, Cummins offers the following comments in response to NHTSA's Notice of Intent to Prepare an Environmental Impact Statement (EIS) for a New Medium- and Heavy-Duty Fuel Efficiency Improvement Program.

Selection Criteria for Preferred NHTSA Alternative

NHTSA is seeking comment on evaluation criteria to select the Preferred Alternative for the Phase 2 program, while achieving the "maximum feasible improvement." To fulfill this requirement, NHTSA should consider the following:

1. Technology advancement – The alternative leads to technology adoption at all levels – vehicle, engine and critical sub-systems.
2. Enforcement – The alternative provides for verifiable procedures and results in use.
3. Criteria pollutants – The alternative maintains linkage of criteria pollutants with fuel efficiency and GHG.
4. Fairness – The alternative avoids unintended consequences and maintains a level playing field.
5. Clarity – The alternative ensures manufacturers know what they need to do to comply.
6. Market efficiency – The alternative preserves the existing market structure which benefits from customer choice and economies of scale in providing engines, powertrains and vehicles to meet customer needs.

Selection criteria such as these ensure that the Preferred Alternative drives a high level of verifiable improvements while balancing criteria pollutant reductions, providing clarity for regulated entities and preserving competition in the market, thereby achieving maximum feasible improvement.

Phase 1 – A Solid Foundation for the Future

In August 2011, NHTSA and EPA finalized the first-ever fuel efficiency and GHG standards for new heavy-duty engines and vehicles in model years 2014 through 2018, known as Phase 1 of the regulation. The public, end-users and the environment are already benefitting from fuel and GHG savings due to successful implementation of the rule. Coordination between the agencies resulted in a single national program with standards and protocols that are aligned between NHTSA and EPA such that manufacturers are developing and certifying single products that comply with both agencies' requirements. The California Air Resource Board (ARB) later harmonized with NTHSA and EPA to further solidify a national program.

Another contributor to the success of Phase 1 is the practical regulatory structure adopted in the rule. As described in NHTSA's notice, "The HD sector is extremely diverse in several respects, including types of manufacturing companies involved, the range of sizes of trucks and engines they produce, the types of work the trucks are designed to perform, and the regulatory history of different subcategories of vehicles and engines." The Phase 1 regulation addressed this diversity with an approach that established separate engine and vehicle standards for vocational vehicles and combination tractors. This reflected the natural partitioning between power supply (the engine, which burns all the fuel and emits all the GHG) and power demand (the rest of the vehicle). This regulatory structure also recognized the non-integrated nature of the commercial vehicle industry and facilitated simple implementation of Phase 1 through reuse of existing protocols for engine criteria pollutant emissions. Building on existing engine emission protocols for certification and compliance provides for quantifiable, enforceable engine fuel efficiency and GHG improvements and ensures those improvements are not made at the expense of criteria pollutants. A similar approach was applied in the Class 2b and 3 pickup and vans market where NHTSA and EPA recycled the chassis-certification protocols to maintain the linkage between criteria and GHG pollutants.

The regulatory structure implemented by EPA and NHTSA for Phase 1 provides a solid foundation for future regulation. As such, separate engine and vehicle standards should be the basis for all regulatory alternatives analyzed by NHTSA for the EIS.

Phase 2 – Building Upon Phase 1

Retaining the Phase 1 framework as the basis for Phase 2 does not preclude making improvements that recognize fuel efficiency improvements from components not included in Phase 1. A number of sub-systems of commercial vehicles, such as transmissions, were not included in order to move quickly and reduce complexity. Phase 2 provides an opportunity to account for additional features and sub-systems. Inclusion of these features can provide manufacturers with new ways to account for fuel efficiency improvements and can provide regulators with new means to encourage technology adoption for additional fuel efficiency improvements. Development of the Phase 2 alternatives needs to consider these new enhancements while maintaining Phase 1 components that have made it a successful implementation.

Maintaining a Single National Program

As done in Phase 1 and directed in the Energy Independence and Security Act of 2007 (EISA), NHTSA and EPA will work together in developing a set of common Phase 2 fuel efficiency and GHG standards. NHTSA also indicates the intention of consulting with ARB with the goal of developing requirements that can be met by a single national fuel efficiency and GHG fleet. A single program was a critical component of the success of Phase 1 rulemaking, and this goal of cooperation amongst the agencies should be continued in the development of Phase 2 alternatives for a single national program.

Clear and consistent regulations provide certainty to manufacturers to invest in the additional cost of developing technologies driven by regulations. Any disparities among agencies' certification or compliance requirements disrupt the ability of manufacturers to amortize the cost of new technologies over the national fleet. In addition, different local standards will drive up cost for engine and vehicle components due to lower volume, showing up in the added cost of vehicles meeting the new separate regulations. In the end, a continued national program such as Phase 1 allows for a more cost-effective regulation with greater fuel-saving and environmental benefits.

The agencies should also provide sufficient lead time and stability for any Phase 2 alternatives. Adequate lead time allows for manufacturers to plan capital investment for technologies that benefit fuel efficiency and GHG. Further, stable standards provide the opportunity to spread capital investment and development cost over several model year engines and vehicles. The net results are minimized cost to products for the end user. Such strategy has been applied for criteria emissions for heavy-duty engines used in commercial engines, where these engines are certified at near-zero emissions levels being driven by regulations with sufficient lead time and stability. Cummins agrees NHTSA and EPA should strive for minimum 4 year lead time and 3 year stability for the Phase 2 alternatives.

Maintaining Separate Engine and Vehicle Standards

The non-vertically integrated nature of the commercial vehicle market allows for multiple suppliers of engines and powertrain options for a given vehicle original equipment manufacturer (OEM). This aspect of the market was recognized in Phase 1, where NHTSA and EPA promulgated separate engine and vehicle standards for commercial vehicles. For reasons discussed earlier, separate engine standards should be included in all alternatives considered for the EIS, and certainly as part of the Preferred Alternative. An alternative that does not include separate engine standards would not meet the important criteria of enforceable standards that will lead to technology adoption, without disrupting the market efficiency.

Additionally, any proposed regulatory framework must consider the alignment between criteria emissions and GHG pollutants. While Phase 1 consisted of complimentary engine and vehicle GHG standards, the engine standards were based on the same test protocols used for criteria emissions. Reusing the established protocols ensured linkage between engine generated criteria and GHG pollutants, forcing consideration of all constituents when optimizing the performance and emissions of heavy-duty engines. Had criteria and GHG pollutants been regulated on different cycles, one could trade-off GHG improvement at the expense of NOx increases. Such a situation would undermine environmental benefits achieved from criteria emission reductions achieved over the years. Therefore, any GHG proposal should consider the capability for aligning criteria and GHG pollutants for current and/or future emissions standards, avoiding any unintended increases in criteria or GHG emissions due to differing test methods.

Optional Powertrain Protocols

The existing Phase 1 regulatory framework utilizes a generic, manual transmission model within the vehicle simulation that captures neither the active nature of certain types of transmissions such as automated manual transmissions (AMT) or automatic transmissions, nor the benefits of closely integrating engines and transmissions in a more optimized manner. This was sufficient for the Phase 1 regulation. However, the framework should be expanded to recognize and encourage the efficiency benefits of integrated engine and active transmission systems. This can be achieved through the addition of a powertrain testing option to the Phase 2 regulation that tests the engine and transmission together to capture the effects of these interactions.

A powertrain testing option, which evaluates fuel efficiency from the engine and transmission together in a test cell, captures critical interactions between the engine and the transmission. The engine and the transmission both contain highly complex controllers that actively control how vehicle torque requirements are met. A powertrain test avoids many of the challenges associated with a full vehicle test while providing a high fidelity measurement of fuel efficiency over powertrain cycles. Such a test protocol may be applied to conventional and hybrid-electric powertrains.

With the addition of well-defined powertrain protocols, engine and transmission manufacturers will have a clear path of demonstrating fuel efficiency and GHG benefits from optimized powertrain systems. This pathway will help to maintain market competition and spur new powertrain technology development.

Fuel Neutral Standards

The Phase 1 regulation adopted different and less stringent standards for gasoline engines and vehicles compared to diesel, putting at jeopardy the environmental intent of the program. As a result, each diesel engine that is replaced by gasoline results in higher GHG emissions, specifically CO_2, per unit work done or miles traveled.

In the vocational engine category, the Phase 1 regulated standards for gasoline and diesel engines diverge over time. The 2010 industry baseline CO_2 for a gasoline engine was 5% higher than the comparable diesel engine CO_2. Instead of bringing diesel and gasoline engines to equivalent standards over time, the Phase 1 standards increase the disparity to nearly 9% by 2017. Additionally, implementation of the standards for gasoline engines is delayed until MY 2016, while the diesel engine standards start in MY 2014.

A similar disparity exists in the heavy-duty pickup trucks and vans category. In 2014, target CO_2 for a gasoline vehicle with a 5000 pound work factor is approximately 1% higher than the diesel vehicle with the same work factor. In 2018, that difference grows to nearly 6%.

A fuel neutral approach has been taken for criteria pollutant standards, which drove higher costs on diesel engines to achieve the same NOx and particulate levels as gasoline. The Phase 1 rule adds to the cost of diesels with more stringent standards versus gasoline. Should Phase 2 continue or grow the disparity on CO_2 standards between diesel and gasoline, these cumulative higher costs will drive customers away from diesel and toward gasoline, thereby increasing CO_2 emissions across the fleet. Phase 2 should correct this disparity by implementing the same CO_2 standards for diesel and gasoline. Although diesel is inherently more efficient, there are promising technologies for improving gasoline engine efficiency, as seen in programs such as Southwest Research Institute's High Efficiency Durable Gasoline Engine (HEDGE) program. A Phase 2 framework that includes fuel neutral standards, as in the criteria pollutant regulatory framework, ensures the environmental and fuel-saving benefits of the regulation are achieved regardless of the fuel chosen.

Advanced Engine Technologies and Potential GHG Reductions

In considering a Preferred Alternative for the Phase 2 program, NHTSA and EPA must be cognizant of potential technologies for diesel engines and powertrains. These developing technologies' fuel efficiency and GHG benefits will directly impact stringency levels of Phase 2 standards. This section will focus on various technologies and their potential CO_2 benefits for the heavy-duty engine and powertrains used in tractor, vocational and heavy-duty pickup trucks and vans.

Tractor Engines and Powertrain Technologies

As shown in Table 1, tractor engine and powertrain technologies provide considerable opportunities for GHG reduction. These potential improvements are based on operation over the SET certification cycle and are relative to the 2017 standard. They assume engine NOx and PM levels that meet the 2010 emissions standards.

The key areas of improved engine efficiency for tractor applications are combustion, air handling, friction and parasitic reduction, and waste heat recovery (WHR) technology. Higher compression ratios, injection pressures and engine structural capability such as higher peak cylinder pressures are also showing benefits in engine efficiency. Organic Rankine Cycle (ORC) WHR technology captures the waste heat from the engine system and returns it as useful work to the crankshaft. This technology has the capability to provide 4 to 5% improvement in fuel consumption on tractor drive cycles.

Powertrain integration is an area that provides further opportunities for efficiency gains, on the order of 3-5% improvement in CO_2. Including optional powertrain testing protocol in the Phase 2 Preferred Alternative will accommodate and encourage such improvements.

2020 – 2030 Potential CO_2 Improvements vs. 2017 Standard for Heavy Heavy-Duty (HHD) Tractor Engines		
	Improvement on the Certification Cycle (%)	**Key Technologies**
Engine	9 – 15	Advanced Combustion Strategies Turbocharger and EGR Air Handling Friction and Parasitic Reductions Increased Peak Cylinder Pressure High Efficiency Aftertreatment Heat Transfer Management Downspeeding Waste Heat Recovery (WHR)
Engine and Powertrain Integration*	3 – 5	Shift Optimization Cycle Efficiency Management Hybrid

**Not realized on the engine certification cycle*

Table 1 - Significant CO_2 reductions are possible for tractor engines/powertrains in the Phase 2 timeframe.

Vocational Engine and Powertrain Technologies

Table 2 summarizes the significant opportunities available to reduce CO_2 from vocational engine and powertrain technology in MY 2020 and beyond. These potential improvements are based on operation over the FTP certification cycle and are relative to the 2017 standard. They assume engine NOx and PM levels that meet the 2010 emissions standards.

Many of the technologies that can reduce tractor engine CO_2 can also reduce vocational engine CO_2. Combustion and air handling improvements will exist in the same form as for tractors; however, CO_2 improvements differ between the two markets due to the lower average cycle power of the vocational market. The highly transient nature of vocational duty-cycles provides further opportunities for fuel efficiency and GHG improvement for transmission integration and introduction of stop/start and hybrid technologies. Integrated transmissions leverage the increased shifting patterns from rapid accelerations to operate the engine in the most efficient points while maintaining acceptable drivability. Meanwhile, hybrid systems recapture and reuse braking energy during decelerations to improve fuel efficiency under these transient conditions. Finally, many vocational duty cycles include

2020 – 2030 Potential CO_2 Improvements vs. 2017 Standard for Medium Heavy-Duty (MHD) Vocational Engines		
	Improvement on the Certification Cycle (%)	**Key Technologies**
Engine	5-11	Advanced Combustion Strategies Turbocharger and EGR Air Handling Friction and Parasitic Reductions Increased Peak Cylinder Pressure Heat Transfer Management High Efficiency Aftertreatment Variable Valve Actuation
Engine and Powertrain Integration*	3-15	Shift Optimization Cycle Efficiency Management Stop/Start Hybrid

**Not realized on the engine certification cycle*

Table 2 – Significant CO_2 reductions are possible for vocational engines/powertrains in the Phase 2 timeframe.

significant amounts of idle time. Engine stop/start systems turn the engine off during idle to save fuel.

There are a range of engine and powertrain technologies that have the potential to reduce CO_2 emissions in the vocational market. The potential benefit and the degree to which that benefit is realized in the real world will depend on the particular technology and the application. Some technologies will provide a consistent benefit for all applications, and other technologies such as hybrid will provide benefits that vary significantly by application and duty cycle. However, improvements to base engine hardware and calibration, engine stop/start and powertrain integration can achieve these improvements more consistently across a wider range of applications in the real world.

Class 2b and 3 Heavy-Duty Pickup Trucks and Vans

Table 3 outlines the technology and reduction levels available to diesel vehicles in this class of heavy-duty pickups and vans. These potential improvements are based

2020 – 2030 Potential CO_2 Improvements vs. 2018 Standard for Diesel Heavy-Duty Pickup Trucks and Vans		
	Improvement on the Certification Cycle (%)	**Key Technologies**
Engine	8-13	Advanced Combustion Strategies Turbocharger and EGR Air Handling Friction and Parasitic Reductions High Efficiency Aftertreatment Variable Valve Actuation Weight Management Stop/Start Transmission Integration
Energy Recovery and Vehicle Technology	3-8	Hybrid Weight Management Accessory Drive Management Aerodynamic Improvements Tire Improvements

Table 3 – Significant CO_2 reductions are possible for heavy-duty pickup trucks and vans in the Phase 2 timeframe.

on operation over the certification cycle and are relative to the 2018 standard. They assume engine NOx and PM levels that meet EPA's Tier 3 emissions standards.

Similar to vocational and tractor engines, combustion and air handling improvements will provide fuel efficiency and GHG improvements. Some of these technologies, such as variable valve actuation, may be familiar for light-duty gasoline engines and vehicles, but are not being developed for diesel applications in the heavy-duty pickup market. For this market, these technologies must be developed to be effective, durable and reliable in order to ensure a benefit to the environment and value to the consumer. As noted earlier, there are also significant gasoline engine technologies for heavy-duty pickup trucks and vans which make fuel neutral standards not only possible but critical to achieving the fuel efficiency and GHG improvements envisioned by the regulation.

Conclusion

In summary, Cummins supports the government's efforts to develop fuel efficiency and GHG regulations for commercial vehicles, as it is the right thing to do for the environment, for the economy and for our nation's energy security. Cummins recommends Phase 1 as the foundation for the Phase 2 Preferred Alternative as it considers the diverse market of classes for tractors, vocational vehicles and Class 2b – 3 commercial vehicles and the impact of different duty cycles and fuel efficiency and GHG technologies. The agencies should work closely together in the development of a single national program that delivers the desired benefits cost-effectively and provides manufacturers certainty and clarity in the timing, framework and standards put in place. Phase 2 should also maintain separate engine-based standards to account for the diversity of applications and duty cycles encompassed by the commercial vehicle market and allow the existing procedures and infrastructure already in place for criteria emissions to be leveraged. Further improvements for Phase 2 would include incorporation of transmissions through powertrain evaluation protocols and fuel neutral standards. Finally, the stringency of Phase 2 should consider the significant potential fuel efficiency and GHG improvements of developing technologies.

When evaluating any Phase 2 alternative, the agencies should consider how the framework leads to technology adoption at all levels and provides clear, fair and enforceable fuel efficiency and GHG standards that are aligned with criteria emissions. The Phase 2 regulations should be designed to ensure a level playing field and preserve market efficiency. These principles will help drive a regulation that provides the maximum feasible fuel efficiency improvement.

Cummins looks forward to working with NHTSA as it continues its work to develop Phase 2 regulations for the commercial vehicle market.