ACEEE
American Council for an Energy-Efficient Economy
529 14th Street, N. W., Suite 600 Washington, D.C. 20045 202.507.4000 202.429.2248 www.aceee.org

Comments of ACEEE on EPA's and NHTSA's Proposed Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Docket ID Nos. NHTSA-2010-0079 and EPA-HQ-OAR-2010-0162

Dr. Therese Langer and Dr. Siddiq Khan
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Introduction

The adoption of fuel efficiency and greenhouse gas standards for medium- and heavy-duty vehicles is a major step toward managing the nation's oil consumption, emissions, and fuel expenditures, and by extension the cost of consumer goods. It also offers the potential of new jobs in the design and production of new vehicle technologies. U.S. manufacturers and suppliers are leaders in certain advanced truck technologies, and this program has the potential to help them consolidate their leadership and thrive in a global market. At the same time, other nations are developing their own programs to improve the efficiency and reduce the emissions of heavy-duty vehicles, and this rule can help set the stage globally.

While it is clear that truck users are sensitive to fuel prices, there are currently major obstacles to bringing efficiency technologies into the market: there is no standardized way of documenting the benefits of these technologies; volatile fuel prices undermine the confidence of manufacturers and buyers to invest in them; and trucks are often sold after just a few years on the road. Given this situation, a fuel efficiency standard is an important tool for promoting the development of new technologies and ensuring their rapid deployment.

EPA's and NHTSA's proposed rule represents a good first step in the difficult job of setting fuel efficiency and greenhouse gas emissions standards for medium- and heavy-duty vehicles. ACEEE supports the adoption of the program starting in 2014, as proposed. We also believe however that the proposal can and should be strengthened to capture more of the available fuel savings, to ensure support for the program among regulated entities and the public, and to establish precedents that will facilitate future improvements in the program.

Major Themes

These comments generally are organized to address specific sections of the proposed rule. Two themes apply across the sections, however, and these relate to the points it is most important for EPA and NHTSA ("the agencies") to address in the final rule: i) the stringency of the standards and their ability to promote advanced vehicle technologies and ii) the need to establish, in this first phase, a pathway toward a full-fledged program.

Stringency of the standards and promotion of advanced technology

The Energy Security and Independence Act of 2007 (EISA) requires that these new standards be "designed to achieve the maximum feasible improvement" (p.74158).[1] In all three truck categories and for engines as well, the standards could and should be strengthened to meet that requirement and to increase the economic benefits of the rule while reducing emissions and oil consumption. High priority issues in each category include:

- Engines – The proposal calls for 6 percent efficiency gains for tractor-trailer engines, for example, where the recent National Academy of Sciences (NAS) study[2] concluded that 8.5-13% improvement would be possible by 2017. The agencies should strengthen the engine standards and also send a clear signal that substantial additional improvements will be required for 2020 to maximize lead time for manufacturers and ensure their continued investment in engine technologies.
- Tractor-trailers – The adoption of trailer standards could reduce fuel use by 10 percent and allow truck manufacturers to optimize aerodynamic features. Trailers stay on the road for a long time, so delay in regulating them will mean lost savings for many years to come. Standards for trailers can and should be adopted in time to ensure their implementation with the first tractor standards in 2014.
- Vocational trucks – The rule should capture the benefits of technologies beyond engine and tire improvements, especially advanced transmissions and weight reduction. Test protocols should be designed to encourage the production of hybrids and other advanced technologies.
- Work trucks – The proposed standards for 2018 have a similar technology basis to the improvements required for light-duty pickups by 2016, yet they take longer and accomplish less. They should be strengthened.

More detailed recommendations on the levels of the standards in each of these categories are provided below. In addition to tightening some of the requirements in this first phase of the program, the agencies should start work as soon as possible on a second phase to commence in 2018, in order to ensure steady progress toward the much higher levels of efficiency shown to be achievable in the NAS report and elsewhere.

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[1] All page references in these comments unless otherwise noted are to EPA's and NHTSA's proposed rule in the Federal Register Vol. 75, No. 229, Tuesday, November 30, 2010.

[2] NAS, 2010. *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles.*

A crucial measure of the success of this rule will be how well it does in drawing advanced efficiency technologies into the market. Indeed, stakeholders' letters of support cited a common set of principles for the regulatory program that include "[i]ncentives leading to the early introduction of advanced technologies" (p.74156). The proposed program should be strengthened in this area, particularly with regard to advanced transmissions, hybrid drive trains and other technologies especially important to the refuse trucks, delivery vans, utility trucks, and school buses in the "vocational" category. Companies investing in these technologies should be given a well-defined, straightforward way of claiming credit for doing so. Demanding standards for vehicles that can take advantage of these technologies will be the best incentive to acquire them as soon as their value has been demonstrated.

We also note that complementary strategies, while not part of the rule itself, could enhance the program's success. Financing mechanisms such as those promoted through EPA's SmartWay Partnership could help owner-operators and smaller fleets with limited resources to realize net savings from more efficient trucks beginning as soon as the trucks are put into operation and continuing throughout the vehicles' lifetimes.

Pathway to a full-fledged program

The agencies must ensure that this first phase of the program enables them to move to a full-fledged program, and in particular a program based on integrated testing and modeling of complete vehicles, in the next phase. Doing so will enable future standards to encourage technologies that the current compliance regime cannot differentiate but can actually cut emissions and fuel consumption. This will require extensive data collection on vehicles, duty cycles, and emissions, as well as extensive work on engine and vehicle drive cycles and modeling.

In the proposed rule, the agencies clearly recognize the need for a new, more sophisticated approach to vehicle testing than currently proposed to "more completely capture the complex interactions of the total vehicle and the potential to reduce fuel consumption and GHG emissions through the optimization of those interactions" (p.74172). The agencies commit to "participate in efforts to improve our ability to accurately characterize the actual in-use fuel consumption and emissions of this complex sector" (p.74156) and mention that they may "begin to develop a knowledge base enabling improvement upon this regulatory framework for model years beyond 2018" (p.74159). Given that these aspects of the first phase are crucial to the long-term efficacy of the program, the building of such a knowledge base and capabilities should be supported by data collection and reporting requirements in the rule itself.

Recommendation (vehicle sales data): Require manufacturers to i) report actual specifications for vehicle configurations sold and ii) run the GEM model using these specifications and report the results.

In the proposed program, test fuel efficiency will not relate closely to real-world fuel efficiency, because the truck as tested will not be the same as the truck as sold. Possible negative consequences of this situation include 1) that truck buyers will not realize the fuel savings implied by the levels at which the trucks are certified and the overall emissions reduction promised for the program will not be achieved, and 2) that manufacturers will tailor vehicles and equipment to do well as tested, not as sold or driven.

Implementing a chassis test for all vehicles as well as a standard that reflects the full variation of truck operating characteristics will be very difficult. It is nonetheless essential that the agencies and regulated entities use the opportunity of the rule's first phase to gather information that will assist in closing the gap between compliance and real-world emissions and fuel consumption in the future. One important step toward that outcome would be to require manufacturers to report actual truck configurations, rather than the standard inputs for engine, transmission and gearing, and the fuel consumption of their vehicles as calculated by GEM using the real specifications.

Furthermore, the actual configuration results should be placed on buyer-oriented vehicle labels. The proposal includes labeling requirements that will have very limited utility to truck buyers. In the case of vocational trucks and tractor-trailers, the label will list the truck features that allowed it to be certified at certain levels for compliance purposes but apparently will not allow a buyer to draw any conclusions about what fuel efficiency he or she might expect to achieve. A label is required to address one of the main barriers that efficiency faces in the heavy-duty vehicle market, namely the lack of standardized fuel efficiency information. Buyers need to be able to compare trucks and to judge likely performance on their own duty-cycles. While duty-cycles famously are as varied as the truckers that drive them, certain key parameters analogous to the city and highway fuel economy figures for light-duty vehicles could go a long way toward providing that information to buyers in a fashion that is consistent across manufacturers, technologies, and model years. More detailed recommendations for a heavy-duty labeling program appear later in these comments.

Recommendation (heavy-duty "Trends" report): Publish an annual report describing vehicles and engines sold, including fuel efficiency and GHG performance and the use of technologies.

The rule should require the preparation of an annual report similar to EPA's publication "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends." The report would allow the tracking of the success of the program and would enhance public understanding of actual technology adoption.

Recommendation (in-use and on-road testing): Collect in-use testing and full vehicle testing data performed by manufacturers, fleets, and federal agencies. Expand agency on-road testing to validate current compliance models and encourage manufacturers and fleets to provide more data. Make data publicly available.

The agencies should collect and publicly disseminate existing vehicle performance data and data generated in future model years. Likewise, data collected through in-use testing should be used to help develop a program of complete vehicle testing and to improve the simulation model. Both simulation results and in-use testing data should be made available to the public.

While data collection regarding heavy-duty vehicles already on the road is likely outside the scope of this rule, the absence of up-to-date data has proven an obstacle in developing this program. The agencies should seek to restore the Vehicle Inventory and Use Survey or initiate a replacement data collection effort as soon as possible.

Recommendation (publicly available compliance data): Publish an annual report describing manufacturer credit balances within each compliance category and the use of any credit flexibility mechanisms, such as advanced and innovative technology credits.

In other to ensure the transparency in the implementation of the standards, certification and compliance information should be compiled by the agencies and made available to the public. Efforts to improve the reporting of corresponding information for light-duty vehicles are already underway.

We conclude this section by noting that the agencies cite the small number of chassis-test facilities as the reason for proposing separate vehicle and engine standards for tractor trucks and vocational vehicles, rather than a chassis-test-based standard (p.74162). The ability to use of chassis testing instead of simulation modeling would not in itself allow the formulation of full-vehicle standards, however. In fact the primary obstacle to a full-vehicle test and standard is not the acknowledged difficulty of chassis-testing all vehicle configurations but rather the diversity of test cycles and multiplicity of standards that would be required to fairly capture the duty cycles of all the full range of vehicles covered by these standards.

Standards for Class 7 and 8 Combination Tractors

Recommendation (trailer standards): Ensure that trailer standards are in place for the 2014 model year, and design tractor protocols accordingly.

The largest shortcoming in the regulation for combination trucks is the omission of trailers. The agencies note that they are not proposing trailer standards but may do so in a future rulemaking (p.74157). We support the agencies' use of the NPRM as an "advanced notice-style" discussion of trailer regulation (p.74346).

Improvements to the aerodynamics of the trailer and of the tractor-trailer as a unit are among the largest, most cost-effective, and most technologically straightforward opportunities for savings. We urge the agencies to ensure that trailer standards are in place for the 2014 model year, both to avoid unnecessary delay in capturing these important savings from trailers and to allow the optimization of tractor aerodynamics in combination with an aerodynamic trailer. Tractor and trailer standards together should achieve at least 30 percent reduction in fuel consumption for these vehicles in 2014.

Recommendation (drag coefficient): Set the baseline and target coefficients of drag for tractor trailers low enough to be realistic and to drive aerodynamic improvements.

The agencies have estimated the baseline aerodynamic drag coefficient value for high roof tractors as 0.69 (p. 74219), which appears high, considering data from published studies. The NAS study suggested that aerodynamically designed tractors have drag coefficient values in the range of 0.60 to 0.65. Researchers from Lawrence Livermore National Laboratory, Sandia National Laboratories, California Institute of Technology, and University of Southern California in an SAE paper in 2000 observed a C_D value of 0.60 for a 80,000 lb Class 8 tractor truck.[3] A 2003 Society of Automotive Engineers (SAE) paper[4] examined full-scale wind tunnel tests that showed a baseline tractor and a 28-foot box trailer having a C_D value of 0.55. Another article by the same author showed that a tractor truck fitted with skirts, rear-end treatment, and gap seal could have a C_D value as low as 0.48.[5] Together, these sources suggest that both the agencies baseline C_D value and the proposed 2017 target C_D value of 0.55 C_D (Advanced SmartWay) for tractor trucks are too high.

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[3] SAE Technical Paper No. 2000-01-2209

[4] SAE Technical Paper No. 2003-01-3376, available at http://papers.sae.org/2003-01-3376

[5] http://books.google.com/books?hl=en&lr=&id=UzJqTX4LPOsC&oi=fnd&pg=PA9&dq=Commercial+Vehicle+Aerodynamic+Drag+Reduction:+Historical+Perspective+as+a+Guide&ots=wII5wZr6Cc&sig=lJiExqGywjdYkzksl7FwEV44zF0#v=onepage&q=Commercial%20Vehicle%20Aerodynamic%20Drag%20Reduction%3A%20Historical%20Perspective%20as%20a%20Guide&f=false

Recommendation (aerodynamics): Ensure comparability of aerodynamics measurements across manufacturers and products, if necessary by requiring coastdown testing. Consider replacement of Cd and CRR inputs to GEM with coastdown test results.

Manufacturers should specify a baseline vehicle test against which to benchmark their coefficient of drag calculations. Unless the agencies can devise a reliable means of ensuring comparable results from the various approaches to determining the Cd, manufacturers should be required to perform coastdown testing, at least on a subset of their vehicles large enough to allow reliable extrapolation to all of their vehicles.

An added advantage of requiring coastdown tests is that the results of those tests could be used directly as inputs to a revised GEM model, which would be the most accurate way to account for both Cd and tire rolling resistance.

Recommendation (idle reduction): Review the amount of fuel savings and GHG emissions reduction assigned to idle reduction. Ensure that no vehicle receiving idle reduction credits has increased PM emissions as a result.

The agencies propose to provide idle reduction credit in the amount of 5 grams of CO_2 per ton-mile to any Class 8 tractor fitted with sleeper cab provided the main engine shuts off after 5 minutes of idling when it is in a parked position. This approach is intended to reduce emissions and fuel consumption from extended idling and allow for the use of alternate technologies to idling of the main engine. In principle, we support the idea of this credit to encourage sleeper trucks to have anti-idle technologies installed on them. The proposal raises two issues of concern, however.

First, the proposed credit is too high. The agencies' estimates of APU fuel consumption of 0.2 gallons per hour and truck engine idling fuel consumption of 0.8 gallons per hour should be revisited. Using chassis data from long haul trucks operating in California, Khan et al. observed a fuel consumption rate of 0.47 gal/hr for those equipped with electronic fuel injection.[6] Furthermore, Gaines observed 0.23 gal/hour of fuel consumption from APUs, on average.[7] Assuming 0.50 gal/hr of fuel consumption from the main engine and 0.23 gal/hr of fuel consumption from APUs, an idle reduction credit of 2 grams per ton-mile would be more appropriate. It should also be noted however that, absent quality control measures, even less efficient idle reduction technologies might be installed in these vehicles for the express purpose of receiving credit for idle reduction.

6 Khan et al. (2006), "Idle Emissions from Heavy-Duty Diesel Vehicles: Review and Recent Data," Journal of the Air &Waste Management Association, Vo. 56, pp. 1404-1419, October 2006.

7 Gaines, L. (2008), "Which Idle Reduction System is Most Economical for Truck Owners," Presentation at the SAE Commercial Vehicle Engineering Congress, Chicago, October 2008.

The proposed credit of 5 grams per mile is a substantial part of the reductions the rule would require of the affected trucks. For example, a high roof sleeper truck would be required to reduce CO_2 emissions by 16 grams per ton-mile (18%) from 89 grams per ton-mile in 2010 to 73 grams per ton-mile in 2014. Idle reduction thus represents one-third of the required reductions for 2014; so it is important that the estimate of savings from idle reduction be realistic.

Gaines also observed that although APUs were saving fuel and reducing total NOx emissions, they have a negative effect on PM emissions compared to truck engine idling. It is not acceptable that the agencies would promote anti-idling approaches that increase diesel particulate emissions. Any tractor that is credited with fuel savings and emissions reductions for anti-idling should be required to demonstrate that its APU or other idling device will not emit particulate matter in excess of what the truck would emit at idle. This can be accomplished for example by equipping the APU with a particulate filter or by routing the APU's exhaust through the truck's emissions control system.

Engine Standards

ACEEE strongly supports the agencies' proposal to regulate engines as well as vehicles. The relatively small number of distinct engines manufactured (p.74159) is one reason for this; the fuel price signal filtered through multiple truck manufacturers and/or models using a given engine will necessarily be more dilute than a direct signal to the engine manufacturer. There are other reasons as well for regulating engines directly for fuel efficiency and emissions, which are discussed below.

Regarding the proposed standards for Class 7 and 8 combination trucks, we note the agencies' observation that "[t]he importance of the engine design is that it determines the basic GHG emissions and fuel consumption performance of the engine for the variety of demands placed on the engine, regardless of the characteristics of the cab in which it is placed" (p.74161). This suggests in particular that inappropriate application of an engine could result in excess fuel consumption, a problem that the rule may aggravate inadvertently, as discussed below.

Recommendation (engine rated power): Specify a range of engine rated power for each subcategory. Require any engine certified in a given subcategory and having a rated power exceeding the range for that subcategory to meet the engine standards using a test with speed-torque points appropriate to a lower horsepower engine.

EPA's existing criteria pollutants regulations for heavy-duty highway engines establish four regulatory categories based on their intended and primary truck application as listed in Table 1.

Table 1: Engine Regulatory Subcategories

Engine Category	Intended Application	Typical Rated Horsepower
Light Heavy-duty (LHD) Diesel	Class 2b through Class 5 trucks	70-170
Medium Heavy-duty (MHD) Diesel	Class 6 and Class 7 trucks	170-250
Heavy Heavy-duty (HHD) Diesel	Class 8 trucks	> 250
Gasoline	Incomplete vehicles less than 14,000 lbs GVWR and all vehicles greater than 14,000 lbs GVWR	N/A

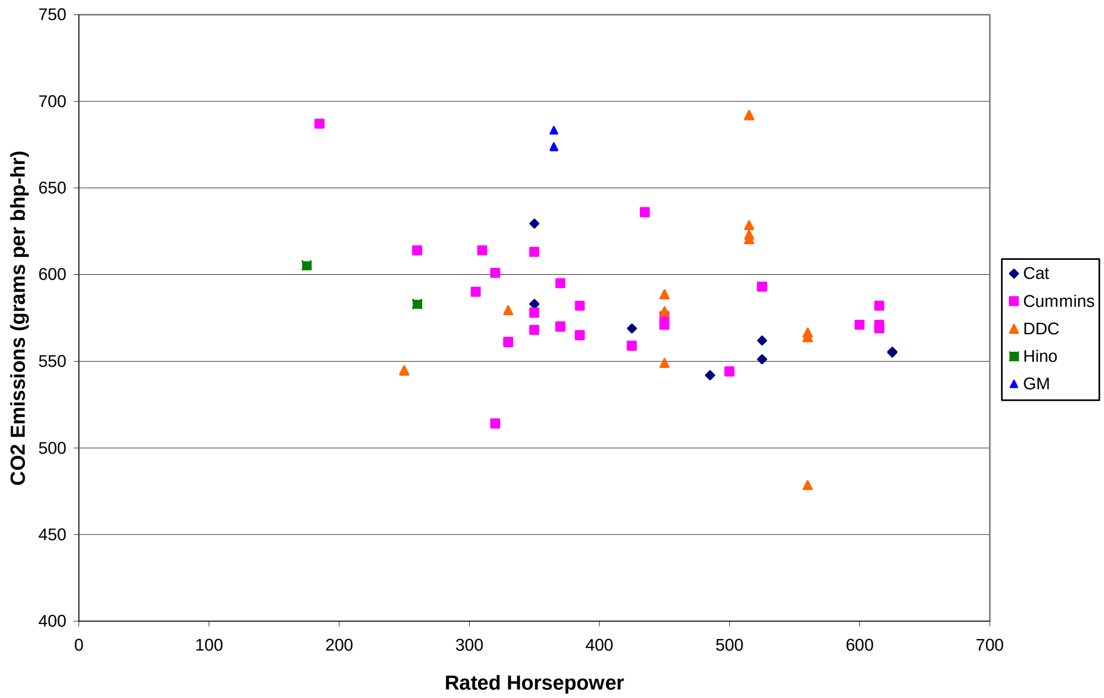
EPA regulations also discuss a range of typical horsepower levels for engines in each of these subcategories, as shown in Table 1.[8] The proposed engine standards would be based on the intended application of an engine, however, and not its rated power (p.74166). At the same time, the test protocol reflects rated power, rather than intended use. This standard structure could have adverse consequences, including the promotion of oversized engines and higher fuel consumption and GHG emissions.

The problem arises from the fact that the standards would be set on a brake-specific basis. In general, a higher horsepower engine will achieve lower brake-specific fuel consumption (gallons per bhp-hr) and GHG emissions (grams per bhp-hr) over a fixed engine test cycle. This general trend is evident from 2009 EPA engine certification data, shown in Figure 1. [9] Hence a higher horsepower engine will more easily meet the fuel consumption and GHG emissions standard for a given application.

[8] See 40 CFR 86.090-2.

[9] See also EPA420-R-00-026 Heavy-Duty Standards/Diesel Fuel RIA – December 2000, Appendix VI-A, http://www.epa.gov/otaq/highway-diesel/regs/ria-vi.pdf, which shows declining gallons per bhp-hr for engines of increasing weight categories.

Figure 1: Brake-specific CO2 emissions by manufacturer from 2009 model year engines (EPA data)[10]



While this information may imply a fuel consumption and GHG emission benefit from increasing engine horsepower, this is not generally the case, for two reasons. First, an engine is most efficient at or near full load. An oversized engine spends more time at lower percent load and consequently achieves a lower efficiency. This is shown quantitatively in the brake-specific fuel consumption map in the draft RIA.[11] The SET and FTP tests measure emissions at points on the engine map that are normalized to engine peak torque and speed, so the amount of time the vehicle operates at inefficient points on the engine map is not captured by the test protocol. Second, a vehicle with an overpowered engine is likely to be driven in a manner different from a vehicle with lower rated power; in particular it may accelerate and climb hills faster. These differences will not be reflected in engine test results, either, because the drive cycle is fixed across vehicles. Also, idle emissions of a bigger engine will be higher. The bigger engine also increases curb weight and consequently reduces payload.

Real-world data supports these concerns. For example, the CRC Study E-55/59 tested more than 40 heavy heavy-duty (HHD) Class 8 tractor trucks. [12] These trucks

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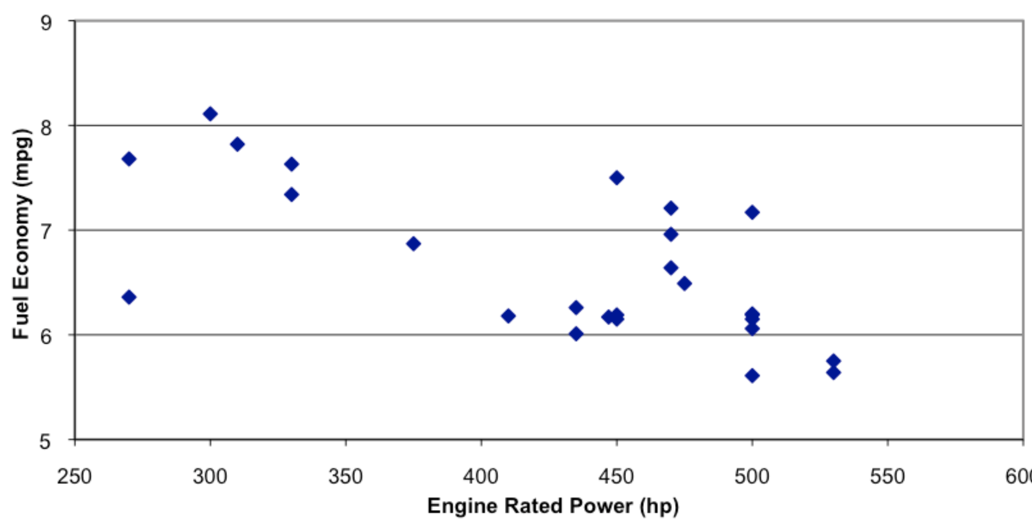
[10] Available at http://www.epa.gov/otaq/certdata.htm#largeng.

[11] Draft RIA, Figure 4-3.

[12] http://www.crcao.com/reports/recentstudies2007/E-55-59/E-55_59_Final_Report_23AUG2007.pdf

had engines ranging from 7.6 liter (L) to 15 L in size and from 215 hp to 530 hp in rated power. The wide range of rated horsepower contributed to a wide range of fuel economy, varying from 5.61 mpg to 8.11 mpg, when tested at a fixed load of 56,000 lbs (See Figure 2).

Figure 2: Tractor-trailer fuel economy vs. rated power – CRC E-55/59 study



To prevent the rule from promoting larger engines and higher fuel consumption, the agencies should specify the typical size range for each of the engine subcategories, as EPA has done in its criteria emissions rule. Any engine with horsepower outside the range suited to the intended application should be shown to meet the standard using the same load as a properly sized engine, i.e. without scaling the load to the outsized engine's peak power.

While the horsepower ranges discussed in the above-cited EPA regulation give no upper bound for a heavy heavy-duty diesel engine, the authors' calculation using the road-load equation shows that a Class 8 truck with 90,000 pounds gross vehicle weight rating (GVWR) will operate 93 percent of its duration with less than 500 horsepower if operated on a CARB HD High Cruise Cycle. The average speed of this cycle is 50 mph, with a maximum speed of 67 mph, a reasonable upper bound for a line-haul trucking duty cycle.

Recommendation (baseline engine emissions): Review the baseline emissions level for vocational engines; revise downward as needed.

The agencies estimate 630 g of CO_2/bhp-hr for 2010 model year baseline LHD and MHD engines and 584 g of CO_2/bhp-hr for 2010 model year baseline HHD engine on the FTP Cycle (p. 74201). Based on the limited FTP certification data available on EPA's web site and other published CO_2 emissions and fuel consumption data, this baseline engine emissions estimate appears to be too high. Brake-specific CO_2 certification data from on-highway heavy-duty diesel engines collected from the EPA site are illustrated in Figure 1. More than 50% of the engines in this dataset had CO_2 emissions less than 580 g/bhp-hr. Model year 2010 engines are more fuel-efficient and low-emitting than their predecessors due to the use of SCR, as noted by Delphi Powertrain System[13] and manufacturers including Daimler and Cummins.[14]

Assuming 2010 engines are approximately 5 percent more efficient than their predecessors as a result of using SCR, a typical engine would be expected to have CO_2 emissions in the range of 550 g/bhp-hr in 2010.[15] This suggests that the baseline CO_2 emissions level specified by the agencies is high. It is critical to have realistic baseline emissions, as the achievable emissions reductions have been calculated as a benefit of the standard will depend heavily on the proper selection of this baseline.

Recommendation (engine test cycles): Develop new test cycles for heavy-duty engines, reflecting intended applications and real-world driving characteristics.

The agencies have proposed testing heavy-duty engines for vocational applications on the HD Federal Test Procedure (FTP) Cycle and engines intended for tractor application on the Supplemental Emissions Test (SET) Cycle (p. 74366). These two cycles are currently used to certify criteria pollutants from the heavy-duty engines. The FTP Cycle was developed in the 1970s, when most vehicles had low power density and were equipped with mechanical fuel injection. Gear ratios in these vehicles during that time were used to limit maximum vehicle speed[16]. Today's heavy-duty engines are more dynamic, have significant but complex electronic control, and more importantly have different transient fuel and air management. Therefore, there is a need for a new, comprehensive engine cycle that reflects today's real-world driving characteristics for vocational vehicles. The FTP Cycle should be replaced with a new, comprehensive set of cycles, at least in the next phase of regulation.

The agencies propose to use only the SET Cycle for CO_2 emissions certification for tractor truck engines. Long-haul trucks do not spend all of their time in steady state driving, however; cycle development for these trucks indicates that they spend a significant amount of their time in transient operation, where fuel consumption and GHG emissions are higher. Indeed, the drive cycle the agencies propose for tractor

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[13] http://delphi.com/shared/pdf/ppd/pwrtrn/scr-dosing-system.pdf.

[14] http://freightliner.cummins.com/attachments/public/english/News/The%20Dispatch/TheDispatch_010710.pdf .

[15] A very small dataset composed of data for 2010 model year heavy-duty diesel engines available at the same EPA site showed that 12 engines of 23 engine emitted less than 570 grams of CO_2 per bhp-hr.

[16] Zhen et al. (2009), JAWMA 59: 950-959.

trucks (not engines) includes a 19 percent share of transient operation for tractors with day cabs. Therefore, there is a need to include certification testing for these engines over a transient cycle.

The agencies express the concern that setting standards based on both transient and steady-state operating conditions could lead to undervaluation of technologies such as turbocompounding that offer benefits primarily in steady-state driving (p.74188). However, the benefits of technologies clearly will be best represented by the use of a weighted set of drive cycles that corresponds most closely to real-world operation.

It would also be in the best interest of the truck manufacturers to develop a comprehensive engine test cycle that can adequately test modern engines and mimic real-world benefits. The European Transient Cycle (ETC), the Worldwide Harmonized Transient Cycle (WHTC), and the Coordinating Research Council's Advanced Collaborative Emissions Test Schedule (ACES) should be examined as candidate test cycles in the future. Alternatively, the agencies could develop a new, comprehensive set of cycles that can be applied to all heavy-duty engines in the next phase.

Recommendation (stringency of tractor engine standards): Increase the stringency of tractor truck engine standards by 3 to 5 percent in 2014 to reflect the availability of mechanical turbo-compounding. Strengthen the 2017 target to reflect technologies including dual stage turbocharging with intercooling and variable valve actuation.

The agencies have proposed separate CO_2 reduction targets for engines for vocational and for tractor truck applications that will be implemented in two phases; in 2014 and in 2017, as showed in Table 2.

Table 2: Proposed vocational and tractor truck engine stringency relative to 2010 model year

Model year	2014-2016	2017+	Test Cycle
Vocational engines	L/MHD: 5%, HHD: 3%	L/MHD: 9%, HHD: 5%	FTP
Tractor truck engines	3%	6%	SET
Gasoline Engine	5%[a]		FTP

a. Effective in 2016 model year

The 2010 NAS Study observed a potential of 6 percent and 15 percent reduction for heavy-duty engines for tractor application in 2014 and 2017, respectively from 2010 model year engine. Similarly, the NAS identified technologies for vocational engines that would deliver reductions of 5 percent and 10 percent in 2014 and 2017, respectively. The NAS analysis implies that stringency for all heavy-duty engines, for both tractor truck and vocational applications, could be strengthened in order to have meaningful savings and consolidate pathways for advanced technologies. The next section will discuss this in detail.

The agencies request comment on the feasibility of more stringent engine standards for 2017, based on waste heat recovery technologies. The NESCCAF and NAS reports cite bottoming cycle, with fuel savings of up to 10 percent, as a technology available by 2017. The standard could reflect this technology even if product cycles preclude its universal adoption, given that manufacturers must comply with standards based on a three-year rolling average and hence would not be unduly disadvantaged if they were to delay adoption by a year or two.

In addition, the proposed engine standard could achieve greater savings even without relying upon a bottoming cycle, according to the NAS. That is because reductions from turbocompounding exceed those required by the standard, as shown by the NAS in its 2015 technology package.

In constructing packages of technologies available to meet new engine standards, the agencies do not consider some promising technologies mentioned in the NAS Study. In addition, their CO_2 reduction estimates for technologies are low. For example, the NAS study indicates that addition of mechanical turbocompounding alone can reduce CO_2 emissions by 3 to 5 percent, while the agencies have assigned 3 percent reduction to turbo-compounding together with other improvements.

The agencies exclude dual stage turbocharging with intercooling, variable valve actuation, electric turbo-compound, and bottoming cycle from their technology package. These technologies were not considered on the ground that manufacturers will be able to comply with the rule using modifications of the existing system rather than wholesale addition of technology. This is not a valid argument for excluding technologies. Any standards should be based on the availability of technologies that provides cost-effective benefits. The agencies omitted mechanical turbocompound from the 2014 target on the grounds that manufacturers may have insufficient lead time for product development and validation. However, the Detroit Diesel Corporation (DDC) has a turbo-compound engine in production (the DD15 diesel engine)[17] in the USA, and Volvo has this technology for engines in Europe.[18] Therefore, this technology could be included in the 2014 package and the stringency could be strengthened. A similar argument could be made for dual-stage turbocharging with intercooling. According to the NAS, this technology provides 2 to 5 percent reduction in fuel consumption and is already being used be some manufacturers in tractor truck engines. A major manufacturer will use this technology for vocational application for its 2011 model year vehicles. Higher

[17] http://www.freightlinertrucks.com/trucks/featured-components/engines.aspx .

[18] Greszler, A. (2008), Presentation at ICCT/NESCCAF Workshop

stringency for both vocational and tractor engines would be possible if this technology is included in the package.

Recommendation (stringency of vocational engine standards): Increase the required emissions reductions for gasoline engines in vocational applications to at least 9 percent in 2017. Also strengthen the standards for diesel engines used in vocational vehicles by at least 2 percent in 2014 to reflect the availability of dual-stage turbo-charging, variable valve actuation, and accessory electrification.

The agencies' gasoline engine package for medium-duty vehicles includes engine friction reduction, coupled cam phasing, and stoichiometric GDI. These three technologies together reduce CO_2 by 6 percent, according to the EPA HD Lumped Parameter Model. The agencies do not consider promising technologies including cylinder deactivation and electrification of accessories, which are cheap but efficient. They asserted that technologies including cylinder deactivation will not be available for production by the 2017 model year (p. 74246). However, the agencies' selection of a vocational baseline gasoline engine that is similar to the baseline gasoline engine used in the light-duty GHG rule suggests that the available technologies are similar for the two engines. Hence cylinder deactivation, which has been available for some time in the light-duty segment, should be considered available for production by 2017. Addition of cylinder deactivation and electrification of accessories, according to EPA's Lumped Parameter Model, increases the CO_2 reductions from vocational engines to 9 percent. Furthermore, the NAS Study projected CO_2 reduction from this package in the range of 8-16 percent. Therefore, the standard for gasoline engines for vocational applications should be strengthened to reduce emissions by at least 9 percent in 2017.

For diesel engines in vocational applications, the agencies have selected the same technology package that they have considered for diesel engines for tractor applications in the 2014 model year. According to the NAS Study, Ford has announced that it will use dual-stage turbo-charging with intercooling in its Class 2b to 7 trucks beginning in 2011. This proven technology can further strengthen the 2014 target by 2 to 5 percent. The 2017 package, unlike the package for tractor truck engines, will not have turbo-compounding, but will rely on CO_2 reductions from additional improvements in the after-treatment system. The exclusion of technologies including dual-stage turbo-charging with intercooling, variable valve actuation and accessory electrification should be reconsidered.

Recommendation (post-2017 engine improvements): Indicate in the final rule the likely trajectory of engine standards out to 2020 at a minimum, based on the NAS study and other sources.

Engine standards for medium- and heavy-duty vehicles should be designed to maximize fuel savings and spur investment in next generation technologies. The proposed standards establish two phases of medium- and heavy-duty engine emissions and fuel consumption stringency levels beginning in model year 2014 and model year 2017. The stringency levels are based on an assessment of engine-related technologies that are currently available today. Additional technologies not captured by the standards are identified but are not evaluated for their potential impact on future engine standards.

Forthcoming technologies could provide major efficiency gains by 2020. The NAS report identified engine technologies that would allow heavy-duty tractor engines to achieve a 13 percent to 17 percent reduction in fuel consumption by 2020, compared to a 2010 engine. These technologies are in many cases being advanced through the SuperTruck program. In comparison, the proposal calls for a 6 percent reduction in fuel consumption by 2017.

The proposed engine standards will improve fuel consumption by requiring the use of off-the-shelf technology, but further advances in engine technology will require greater incentives. Laying out a technical roadmap and likely trajectory for engine standards beyond 2017, e.g. in the discussion on p.74172 of the rule, would encourage further investment, development, and deployment of these technologies.

Recommendation (alternative engine standard): Reconsider the need for the alternative engine standard. Do not extend the proposed alternative or lower the required percent reductions.

The proposed rules would allow engine manufacturers to meet an alternative, presumably less stringent, standard through 2016 (pp.74178-74179). This provision would permit a manufacturer with an engine model having emissions higher than the industry average to achieve the same percentage emissions reduction from 2011 levels that the standard requires relative to the industry average. It is not clear that this provision, which can only reduce GHG and fuel savings from the rule, is necessary, because the proposed standards are not very stringent. The proposal offers no data supporting the need for such a provision, noting only that certain engine families are substantially below the industry average. Whether manufacturers might reasonably be expected to offset the greater reductions required of these engines by additional savings from other engine families or by using banking or trading provisions was not discussed in the proposal. Moreover, the provision could incentivize certain undesirable actions, such as the use of a particularly inefficient representative of the affected engine family to represent the family's 2010 average and hence its target through 2016. If the agencies believe that this alternative standard is essential and adopt it, then they should require that any engine used to establish a baseline is truly representative of the engine family. They should also require, at a minimum, that any manufacturer that takes advantage of the alternative standard must compensate for its greater emissions and fuel consumption in 2017-2018.

The agencies request comment on the suggestion that this alternative engine standard be expanded by i) allowing manufacturers to reduce a family's emissions by a lesser percentage than the basic standard would require of other engines; and/or ii) extending the period in which manufacturers could use the alternative standard through 2017. These expansions of the alternative standard should not be adopted.

Standards for Class 2b-8 Vocational Vehicles

Recommendation (stringency of vocational vehicle standards): Strengthen vocational vehicle standards to reflect the potential for at least 5 percent (light and medium vocational) and 3 percent (heavy vocational) savings from transmission and driveline improvements and weight reduction.

The proposed standards for vocational trucks would yield 2 percent savings beyond what is gained through engine efficiency improvements, reflecting the benefits of low rolling resistance tires alone. The potential for savings among these vehicles is far greater than 2 percent. While setting standards for vocational vehicles is complex due to the wide variety such vehicles, which have very different features and duty cycles, it is important that the rule do more to promote advanced technologies for this subsector.

The findings in the NAS report regarding potential reductions in fuel consumption for four types of vocational vehicles (Class 6 box, Class 6 bucket, Class 8 refuse, and urban bus) are shown in Table 3.

Table 3: NAS Estimates of Fuel Savings Opportunities for Certain Vocational Trucks[19]

		Transmission and driveline		Mass reduction		Aerodynamics		Hybrids
		2013-2015	2015-2020	2013-2015	2015-2020	2013-2015	2015-2020	2015-2020
Class 6	Box	1.5%	4.0%	2.0%	4.0%	3.0%	6.0%	30.0%
Class 6	Bucket truck	1.2%	3.2%	1.6%	3.2%	N/A	N/A	40.0%
Class 8	Refuse	1.5%	4.0%	0.0%	1.0%	N/A	N/A	35.0%
Class 8	Urban bus	1.5%	4.0%	3.0%	6.3%	N/A	N/A	35.0%

[19] Savings estimates from NAS 2010, Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles, p 4-29 and Tables 5-10, 5-18, and 6-2.

The standards reflect none of these vehicle savings opportunities. The explanation for this, in general, is not that the agencies have rejected the NAS report findings, but rather that there are obstacles (real or perceived) to capturing these savings given the structure and protocols of the rule. For example, it is not clear how the standards could reflect aerodynamic improvements involving the body, given that a single chassis may be used with multiple bodes and that the chassis manufacturers are the regulated entities for vocational vehicles. Full vehicle testing, together with further segmentation of vocational vehicles and perhaps a change in regulated parties, will be needed to drive maximum fuel savings.

In the meantime, however, other technologies cited by the NAS can and should be reflected in the standard. An improvement of 3-4 percent in 2015-2020 appears to be a reasonable expectation for transmission and driveline improvements in the vocational segment generally, through a combination of 8-speed automatic transmission, reduced driveline friction and automated shift logic (NAS p. 6-13).[20] For Class 3-6 box trucks, a very large group of vocational vehicles, as well as bucket trucks, the NAS estimates a capital cost of $1800 for these transmission savings, implying a payback of about two years. Box trucks and bucket trucks account for much of Class 6 in particular, which is responsible for 10 percent of all Class 2b-8 fuel use.[21] Similar transmissions gains are presumably available for platform trucks as well. On this basis, it seems quite reasonable to assume a cost-effective benefit from transmission and driveline improvements of 3 percent by 2017 across vocational vehicles.

The agencies make the case that optimization of gearing is specific to the complete vehicle and therefore cannot be driven by a rule applicable to chassis manufacturers (p.74241). If savings are widely available across the sector, however, it is important that the basic compliance package for vocational vehicles, as well as the stringency of the standard, capture this potential. Any manufacturer that can demonstrate a substantial fuel savings potential of a transmission through an A-to-B chassis test over the vocational drive cycle(s) adopted for the rule should be permitted to assign those savings to all vocational vehicles using that transmission. The GEM model should be modified to accept this information as an input. Alternatively, the agencies could treat transmission and driveline improvements as off-cycle technologies and assign a fixed percentage savings for the inclusion of an appropriate technology (e.g. AMT or dual clutch transmission). This would be similar to the treatment of idle reduction for tractors with sleeper cabs.

The NAS discussion of weight reduction similarly indicates the potential for savings in the vocational sector, at least for light and medium heavy-duty trucks. While some of this potential may reside in the bodies, we would expect that much of the

[20] In fact, at least one transmission manufacturer is claiming savings of more than 8 percent for vocational trucks on average using automated manual or dual clutch transmissions to replace the torque converter automatics that now dominate the market.

[21] Calculated from data in the *Transportation Energy Data Book*, Edition 27.

opportunity for weight reduction would be in the chassis, or in components under the control of the chassis manufacturer. A baseline vehicle weight against which to measure weight reductions cannot be assigned from the chassis alone, but fuel savings from reductions in the weight of specified components can nonetheless be estimated through GEM, in the same way that the model reflects reductions in wheel and tire weight for tractors. A reasonable estimate of savings potential from weight reduction would be 2 percent for light and medium heavy-duty vocational vehicles in 2017.

Thus we recommend that 2017 standards for vocational vehicles include savings of 5 percent for light and medium heavy-duty vocational vehicles and 3 percent for heavy heavy-duty vocational vehicles from transmission and driveline improvements and weight reduction. The standards would then reduce light and medium vocational vehicles' fuel consumption and GHG by 14 percent (instead of 10 percent) and heavy vocational vehicles' emissions by 10 percent (instead of 7 percent) relative to the 2010 baseline.

In addition to savings from transmission improvements and weight reduction, vocational vehicles' anticipated benefits from hybridization are large. According to the NAS, hybrid savings available in 2015-2020 will range from 30 to 40 percent for the vehicle types listed in Table 3 above. NAS' estimated cost for a parallel hybrid Class 3-6 box truck is $20,000, implying a payback of three years (NAS Table 6-6). Hydraulic hybrids, discussed in the next section, offer large savings at a lower cost for certain applications.

Significant penetration of hybrids is anticipated in the vocational sector in the near future. For example, Pike Research projects 300,000 medium- and heavy-duty hybrid sales, or 7 percent of projected sales, by 2015.[22] At this sales level and per-vehicle fuel savings of 35 percent, vocational vehicles' savings from hybridization would be over 2 percent on average by 2015. These savings are not reflected in the standards.

Standards for Heavy-Duty Pickup Trucks and Vans

The agencies rightly point out that "Class 2b and 3 complete vehicles share much more in common with light-duty (LD) trucks than with other heavy-duty vehicles" (p.74189). They also observe that manufacturers often incorporate new light-duty truck design features into heavy-duty pickups and vans at their next design cycle. The 2012-2016 fuel economy and GHG rules will require large light-duty pickup trucks to reduce fuel consumption in the range of 16 percent from 2010 levels.[23] To

[22] Pike Research http://greenbigtruck.com/2010/06/pike-research-forecasts-300000-medium-heavy-duty-hybrids-by-2015; AEO 2010.

[23] The 2012-2016 light duty rule sets a target of 24.7 mpg for the 67 sq. ft. Silverado in the rule. Average adjusted fuel economy for large pickups was 16.6 mpg in 2010 (EPA 2010 Fuel Economy

the extent that the technologies brought to market by the 2012-2016 LD rules are applicable to heavy-duty pickups and vans as well, the heavy-duty GHG rule should set a reduction target comparable to the percent reduction required in the light-duty rule for 2016. Light-duty trucks will again undergo improvements to reflect the forthcoming rule fro 2017-2025, which will help to achieve a higher target for Class 2b and 3 vehicles for 2018 and beyond.

Recommendation (standards stringency): For gasoline pickups and vans, strengthen the standard to achieve at least 15 percent reduction. Consider a more stringent standard for diesel vehicles as well. Consider accelerating these reductions to 2016.

The proposed standards for 2018 would yield average CO_2 emissions 10 percent lower for gasoline vehicles and 15 percent lower for diesel vehicles relative to 2010 model year vehicles. This stringency is inadequate. The Annual Energy Outlook (AEO) 2010 projects an 11 percent reduction in CO_2 in 2018 for commercial vehicles weighing 8,500 to 10,000 pounds, largely the same vehicles under consideration here, in a reference case that does not include the effects of this rule.[24] The proposed standard falls short of what could be achieved by these vehicles because i) the technology package the agencies cite to justify their proposed stringencies could achieve larger reductions, and ii)certain promising technologies for these vehicles were not included in the agencies' package demonstrating feasibility of the standards.

In a memo to the docket, the EPA shows CO2 reductions from the agencies' diesel package of 14.2 to 18.5 percent. The proposed reduction is near the bottom of this range. [25] Furthermore, the fact that the work-factor-corrected baseline emissions for diesel vehicles is roughly the same as the gasoline baseline, despite the inherent efficiency advantages of diesel engines, suggests that manufacturers of current diesels in this category have been slow in adopting fuel-saving technologies.

For gasoline vehicles, the agencies also do not include cylinder deactivation and coupled cam phasing in their proposed package, which in their own assessment are very cheap (under $250 combined) and reduce CO_2 by 4-8 percent. Major manufacturers including Honda, GM, Mercedes Benz, and Chrysler have already included these technologies into their light-duty fleet.[26] Adding these two technologies to the agencies' package for gasoline vehicles, results in a revised

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Trends Report) or approximately 20.8 mpg unadjusted. Hence the light-duty rule requires a reduction in fuel consumption of about 16 percent.

[24] EIA "Assumptions to the Annual Energy Outlook 2010," http://www.eia.doe.gov/oiaf/aeo/assumption/transportation.html.

[25] October 18 EPA memorandum in the docket "Process for Determining Class 2b and 3 CO2 Standard." Also, the EPA HD Lumped Parameter Model that ACEEE obtained through the docket shows 12 percent and 19 percent CO_2 reduction from gasoline and diesel vehicles, respectively, for these packages, so it is unclear how the agencies arrived at the lower figures.

[26] http://www.jdpower.com/autos/articles/Engine-Cylinder-Deactivation-Saves-Fuel/

package costing $1,607 and providing a CO_2 reduction of 15 percent from a 2010 model year vehicle, according to the HD Lumped Parameter Model. This revised option offers an attractive payback of 4 years.

Recommendation (additional technologies): Evaluate the feasibility of other promising technologies including turbo-GDI and hydraulic hybrids for gasoline vehicles.

The proposed standard does not take advantage of some advanced yet available technologies including Turbo-GDI, which combines S-GDI, turbo-charging, and downsizing for gasoline vehicles. According to the TIAX 2009 report submitted to the NAS, this package would reduce CO_2 emissions for large trucks by 11-17 percent compared to stoichiometric GDI, at an added cost of $2000-$3000. The 2010 NAS study estimated 10-14 percent reduction potential for CO_2 from turbocharged downsized direct injection engine with variable valve actuation (VVA). Delphi Powertrain Systems observed that about 18 percent CO_2 reduction was possible on the New European Driving Cycle (NEDC) with Turbo-GDI that employed a 3-way catalytic converter in comparison to a port-fuel naturally aspirated gasoline car.[27] Ford has already adopted gasoline direct injection and turbochargers for the 2011 Ford F-150 model truck with 11,000 lbs towing capacity. [28] Testing on this truck has confirmed its durability for more than 150,000 miles on test track encompassing the full range of potential customer operating conditions. Turbo-GDI is also available for Honda vehicles from 2010 model year.[29] If Turbo-GDI is included in the agencies' package for gasoline vehicles and mass reduction is omitted, the revised package then reduces CO_2 emissions by 18.7 percent to 33.7 percent at a cost of $3200. Assuming the midpoint of this range of savings (26 percent), this package has a payback of 4 years, still better than the payback of the agencies' proposed package.

Another important technology that the agencies have overlooked in this rule is hydraulic hybrid systems for Class 2b and 3 vehicles, as well as for vocational vehicles. Recently EPA and Chrysler entered into a cooperative agreement to develop and adapt hydraulic hybrid technology for the light duty auto market.[30] EPA anticipates that the hydraulic hybrid technology will increase overall fuel efficiency by 30-35 percent and reduce overall GHG emissions by 25 percent. The NAS in its study also anticipated an 18-30 percent GHG reduction from hydraulic hybrids for Class 2b and 3 vans and 20-35 percent for vocational vehicles. The savings estimate was higher for Class 6 bucket trucks (up to 45 percent) and transit buses (up to 50 percent). This technology has already been introduced in vocational vehicles by

[27] SAE Technical Paper 2010-01-0590.

[28] http://media.ford.com/article_display.cfm?article_id=33260

[29] Sakai, I. (2009), "Future of Transportation in the Carbon Constrained Environment – Technical and Policy Perspective of American Honda Motors,"

[30] http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/837c1d022dba18448525781d005995be!OpenDocument

Eaton, Crane Carrier, and Parker Hannifin. At a cost of $1200,[31] the hydraulic hybrid would provide a very attractive payback of little more than one year for Class 2b and 3 van users.

Recommendation (combined gasoline and diesel standards): Consider a single standard for gasoline and diesel vehicles.

The agencies assert that "[the required] reductions represent roughly equal stringency levels for gasoline and diesel vehicles, which is important in ensuring our proposed program maintains product choices available to vehicle buyers" (pp.74195-6). It is not clear why the agencies regard the proposed stringencies as equivalent, given that the baselines for gasoline and diesel are approximately the same, while diesel vehicles are required to achieve 15 percent reductions and gasoline are required to achieve 10 percent reduction. With a required emissions reduction of 15 percent for gasoline vehicles as recommended above, standards for gasoline and diesel vehicles would indeed be roughly equivalent.[32] In that case, a combined, fuel independent standard would appear to offer greatest flexibility and greatest potential to drive fuel savings and emissions reductions.

Recommendation (low rolling resistance tires and low-friction lubricants): Assign benefits to the rule only for the tires and lubricants sold with the vehicle unless and until standards are adopted for those products.

No compliance mechanism has been proposed for the use of low RR and low friction lubricants; the agencies simply assume that owners will replace these items with similar, efficient products as needed. This is not a reasonable assumption. Any savings attributed to low RR tires and low friction lubricants should apply only to the initial tires and lubricants, unless and until standards for those products or some other mechanism is put in place to ensure the replacements will have similar efficiency properties.

Recommendation (test cycles for heavy-duty pickups and vans): Choose test cycles for heavy-duty pickups and vans that adequately represent real-world driving conditions, including high-speed driving, use of air conditioning, and cold-temperature operation.

In choosing test cycles for this new regulatory program, the agencies should take advantage of the experience of several decades with the light-duty program to adopt realistic test cycles for heavy-duty pickups and vans. The light-duty test cycles were shown in EPA's 2006 light-duty labeling rule to overstate fuel economy by more

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[31] EPA Staff Technical Report, EPA420-R-08-008, March 2008.

[32] Equivalent CO2 emissions standards for gasoline and diesel vehicles would correspond to roughly equivalent fuel consumption standards if diesel consumption were expressed in gasoline-energy-equivalent gallons per mile. ACEEE supports this energy equivalent metric rather than a volumetric measure of consumption, both for this rule and for light-duty vehicle standards.

than 20 percent on average across vehicles and to be unable to detect certain technology- and weight-related determinants of fuel economy. The agencies have proposed to use these same cycles (the FTP and the HFET) as test cycles for heavy-duty pickups and vans. While choosing more representative cycles over which to test the fuel economy of cars for certification purposes would require a change in law, there is no such limitation on test cycles for heavy-duty pickups and vans. Moreover, the EPA has already developed a more a more representative set of test cycles (the "5-cycle test") for light-duty labeling purposes, which provides at least a good starting point for establishing a cycle for heavy-duty pickups and vans.

Flexibility provisions

The function of flexibility mechanisms is to allow maximum savings at reduced cost. The proposed rule sets out stringency requirements that in most cases challenge the industry, not to improve technology, but only to adopt technologies that are readily available. In these circumstances, flexibility mechanisms will simply allow some vehicles that could easily be upgraded to remain inefficient and promote the use of advanced technologies to offset the high fuel consumption of these lagging vehicles, rather than to achieve additional fuel savings. The proposed flexibilities would be better justified if the stringency of the standards were increased, as discussed previously.

Recommendation (credit multipliers): Do not adopt multipliers for advanced technology credits or early credits.

ACEEE promotes flexibility provisions that are effective and preserve or increase fuel savings and GHG emissions reductions. Given the weakness of the standards proposed for the vocational truck category, it is improbable that flexibility provisions would be useful or necessary there. Credit multipliers, whether for advanced technologies or early credits, are especially to be avoided, because they lessen the total emissions reductions from the program by allowing a greater increase in the emissions of other vehicles than they offset.

Recommendation (electric vehicles): Account for full fuel-cycle emissions of electric vehicles.

The agencies propose treating electric vehicles as zero emissions vehicles for purposes of the standards (p.74364). ACEEE and others commented on potential adverse effects of treating electric vehicles as zero emissions vehicles in the 2010 light-duty fuel economy and GHG emissions rule. These adverse effects, including the loss of the incentive to maximize the energy efficiency of electric vehicles and the net increase in total GHG emissions due to non-electric vehicles' ability to emit more, apply equally to the heavy-duty vehicle sector. The standards should instead account for full fuel-cycle emissions from these vehicles, adjusted as needed to reflect the fact that the standards for gasoline and diesel vehicles apply to "in-use" emissions only.

Recommendation (hybrid vehicles): Carefully define hybrid testing protocols.

The rule would allow manufacturers to obtain credit for hybrids and certain other "advanced" technologies using defined test protocols. The use of all three methods sketched in the proposed rule to demonstrate hybrid benefits should be permitted: either chassis testing or "power pack" testing, the latter in either the pre- or post-transmission versions. These protocols should be further developed in the final rule to ensure ease of use, reliable measurements of savings, and cross-test comparability.

Recommendation (innovative technology credits): Specify allowable protocols for attributing fuel savings and GHG reductions to advanced transmissions and, to the extent possible, other efficiency technologies.

Credits are also available for "innovative" technologies if savings from these technologies can be demonstrated to the satisfaction of the agencies. In the case of advanced transmissions, both the chassis test and the post-transmission power pack options should be available for demonstrating benefits, and the final rule should state this explicitly.

For innovative technology credits more generally, the agencies should provide extensive guidance on eligible technologies, pre-approved test protocols, and suitable test cycles. Doing so would give manufacturers the certainty that they could gain credits for these technologies in a well-defined and straightforward fashion, reducing risk and expense and thereby helping to simulate technology development and adoption. Increasing the stringency of the standards will add to the value of innovative and advanced technology credits.

Recommendation (innovative technology credits): Keep the application of innovative technology credits to the same class in which they were earned.

An alternative means of increasing the value of innovative technology credits would be to permit them to be applied to any compliance category, regardless of where they were generated. The agencies have proposed not to allow this (p.74189), however, and they should not allow it in the final rule. Especially in this first phase of the program, when several of the standards are lacking in stringency and there are uncertainties about how, and how many, innovative technology credits will be generated, it is important to ensure some progress in each category of engine and vehicle. Allowing these credits to be applied across compliance categories could result in certain categories' achieving no fuel savings or GHG emissions reduction, despite the availability of cost-effective options for doing so. It could also give unfair advantage to certain manufacturers that have a broader range of products, as the agencies note.

Labeling

Lack of consistent fuel efficiency information for buyers of trucks, both new and used, is a barrier to greater efficiency. All vehicles and engines should carry labels that provide the buyer with fuel consumption and GHG emissions information that will help in choosing among products with similar functionality.

The labeling provisions of the proposed rule are minimal and are clearly intended to facilitate compliance and enforcement, rather than to provide consumer information. Given that lack of standardized fuel consumption information is a barrier to faster adoption of efficiency technologies in the heavy-duty vehicle market, it is important that a consumer-oriented label be put in place to support the new standards.

Recommendation (labeling): The final rule should require that fuel consumption and GHG emissions information for all vehicles and engines covered by the rule be made available in a buyer's guide on an annual basis.

The agencies specifically decline to require fuel consumption labeling, because they believe it could mislead the purchaser (p.74352). As for other products, including light-duty vehicles, medium- and heavy-duty vehicle labels cannot be expected to provide information that predicts individual users' energy use; labels are designed to help guide comparisons made in the purchasing process. How to provide information that is helpful rather than misleading to the consumer is a perennial challenge for labels. However, this challenge has been met in other cases through careful design of the label, and updating as needed, rather than by declining to provide the information at all. If the standards can be relied upon to reduce fuel consumption, as we believe they can, then it must be the case that vehicles' certification values relative to those standards would be meaningful information to buyers.

In the final rule, the agencies should indicate their intention to issue a rulemaking for labeling of the vehicles and engines covered by this rule. In addition, the final rule should require the issuance of an annual buyers guide similar to the Fuel Economy Guide that EPA and DOE issue for light-duty vehicles. The guide would list, for each vehicle and engine subject to this rule, fuel consumption and GHG emissions rates, along with other information helpful for comparing and understanding the performance of these vehicles and engines.

Recommendation (labeling of engines, tractors and vocational vehicles): The final rule should require that engine, tractor, and vocational truck labels include the Family Emissions Limits, regardless of whether the manufacturer is participating in ABT.

Under the proposed rule, engine and vehicle labels would provide product specifications to facilitate identification and ensure in-use compliance. However, the proposed rule appears to require that the label state the product's certified emissions, or "Family Emissions Limit", only if the manufacturer is using ABT (p.74268). Fuel consumption information is not required on the label at all. Whether or not the manufacturer is participating in ABT, GHG emissions and fuel consumption information should be provided on the label.

Recommendation (buyer-oriented label): The final rule should include information and discussion in preparation for a subsequent labeling rule requiring that tractor and vocational truck labels list the vehicle's fuel consumption and GHG emissions on each test cycle, in addition to the weighted average used for certification. Where possible, the values should reflect the actual vehicle configuration, rather than the standard GEM model inputs specified for certification purposes.

Moreover, the label should include information designed to be most useful to the buyer. At a minimum, it should allow comparisons across similar vehicles or engines and promote the deployment of efficiency technologies.

Elsewhere, we have recommended that among the data that manufacturers should report to the agencies for each vehicle model are fuel consumption and GHG emissions as calculated by the GEM model using actual vehicle specifications, including engine, transmission, frontal area, etc., rather than the generic inputs required for certification purposes. We recommend that this information be displayed on a buyer-oriented vehicle label as well.

In addition, displaying fuel consumption and GHG emissions on each of the required test cycles (transient, 55 mph cruise, and 65 mph cruise) separately, in addition to the specific weighted sum required for certification purposes, would allow buyers to better understand the suitability of a given vehicle for their duty cycle.[33] In fact, research conducted by West Virginia University for the International Council on Clean Transportation provides evidence that fuel consumption and GHG emissions over any heavy-duty drive cycle can be reasonably well approximated as a weighted sum of fuel consumption and GHG emissions over certain standard drive cycles.[34] The weightings are determined by certain parameters associated with the drive cycle, such as average speed and average acceleration. Various combinations of three drive cycles, including some similar to the cycles proposed in the rule, were shown to produce good results.

[33] Some commenters have rightly questioned the choice of these three cycles, in particular the transient cycle. The value of reporting fuel consumption and emissions over all required test cycles does not depend on the particular cycles proposed by the agencies, but would carry over to other cycles that the agencies may choose to use.

[34] Clark et al 2009 http://www.theicct.org/pubs/WVU_Final_Report_ICCT.pdf .

Hence it is likely that a buyer in principle could use fuel consumption values over the three cycles used for compliance testing to estimate the fuel consumption of a given vehicle knowing the characteristics of his or her own duty cycle. Showing the individual test cycle results on the label would be similar to listing city and highway fuel economy on the Monroney label; the car driver can form an opinion of the value to him or her of high city or highway fuel economies, based on his or her own driving habits. In the WVU work, the parameter on which that view is based is not the split of miles driven into city and highway, but rather the split of time spent in each of three modes. That split could be measured by average speed and acceleration.

Issues arising from this proposal call for further investigation. For example, while truck fleets are likely to know the average speed over their duty cycles, they are less likely to have average acceleration data (though this can be approximated from second-by-second speed data if available). Also, the estimates of fuel consumption and GHG emissions produced by this method may differ from real-world values by a greater percentage than the required percentage improvement under the standard. These and other issues should be explored further in the development of a buyer-oriented label for vehicles regulated under this rule.

Recommendation (labeling of heavy-duty pickups and vans): The final rule should include information and discussion in preparation for a subsequent labeling rule requiring that heavy-duty pickups and vans carry a label similar to the light-duty Monroney label. The label should include fuel consumption and GHG emissions in an appropriate metric, supplemented as needed with payload and towing capacity information.

Under the proposed rule, the label for heavy-duty pickup trucks and vans would continue to show compliance with criteria pollutant standards only (p.74263). A label similar to the light-duty vehicle label would be appropriate for these vehicles, however.

Miles per gallon values for heavy-duty pickups and vans may be far lower than those for similar vehicles with GVWR under 8500 pounds due to the higher test weights (curb weight plus half payload) specified for the heavy-duty vehicles. This has apparently raised a concern among manufacturers that such a label could unfairly disadvantage the heavy-duty vehicles in any cross-class comparisons that a consumer may make. However, the basis for the structure of the proposed standards, which vary by vehicle "work factor", is that these vehicles are used for work purposes and that their buyers do not have the option of substituting vehicles with the towing capacity and rated payload of light-duty trucks. Hence this concern regarding shifting purchasers across classes seems unwarranted.

Furthermore, there are several possible approaches to designing a label that would address the differences in test weight, including:

- Noting prominently that the vehicle is a "work truck" and changing label design features to highlight this difference; and
- Testing these vehicles at the light-duty test weight (as well as at the compliance test weight) and reporting that information on the label as well.

Program Impacts

In discussing their framework for evaluating impacts of the rule (p.74303), the agencies review five market barriers to adoption of heavy-duty efficiency technologies. They do not however consider supply side barriers, which may also contribute substantially to the discrepancy between the engineering analysis of potential cost-effective improvements and real-world technology adoption. These barriers include vehicle and parts manufacturers' costs to bring advanced technology to market. While the technologies relied upon to meet the proposed standards have already been commercialized by at least one manufacturer, the cost to other manufacturers of developing the same technology may be considerable.

For future phases of these standards, research and development costs may become a far larger barrier. The high cost of technology development for a relatively small market (compared, for example to the light-duty vehicle market), along with volatile fuel prices, may cause manufacturers to be especially risk-averse in the absence of standards that will ensure a future market for highly efficient products. Manufacturers may also be highly subject to "first mover" penalties, which result from making large investments in developing technologies that are then adopted at low cost by competitors.

Another consideration is the fact that heavy-duty vehicle manufacturing is not vertically integrated. Manufacturers of engines, transmissions, and other components, who are at least one step removed from buyers, may find it difficult to generate a demand for efficient products through their OEM customers.

Conclusion

In conclusion, ACEEE strongly supports EPA and NHTSA's development and adoption of greenhouse gas and fuel efficiency standards for all medium- and heavy-duty vehicles starting in model year 2014. We recommend that the agencies strengthen the proposed rule in several areas as discussed above to ensure that the program achieves maximum economic and environmental benefits and sets a strong precedent for future phases of the program.