AUTHENTICATED U.S. GOVERNMENT INFORMATION GPO

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 9, 22, 85, 86, 600, 1033, 1036, 1037, 1039, 1042, 1043, 1065, 1066, and 1068

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Parts 512, 523, 534, 535, 537, and 538

[EPA–HQ–OAR–2014–0827; NHTSA–2014–0132; FRL–9927–21–OAR]

RIN 2060–AS16; RIN 2127–AL52

Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2

AGENCY: Environmental Protection Agency (EPA) and Department of Transportation (DOT) National Highway Traffic Safety Administration (NHTSA)

ACTION: Proposed rule.

SUMMARY: EPA and NHTSA, on behalf of the Department of Transportation, are each proposing rules to establish a comprehensive Phase 2 Heavy-Duty (HD) National Program that will reduce greenhouse gas (GHG) emissions and fuel consumption for new on-road heavy-duty vehicles. This technology-advancing program would phase in over the long-term, beginning in the 2018 model year and culminating in standards for model year 2027, responding to the President's directive on February 18, 2014, to develop new standards that will take us well into the next decade. NHTSA's proposed fuel consumption standards and EPA's proposed carbon dioxide (CO_2) emission standards are tailored to each of four regulatory categories of heavy-duty vehicles: Combination tractors; trailers used in combination with those tractors; heavy-duty pickup trucks and vans; and vocational vehicles. The proposal also includes separate standards for the engines that power combination tractors and vocational vehicles. Certain proposed requirements for control of GHG emissions are exclusive to EPA programs. These include EPA's proposed hydrofluorocarbon standards to control leakage from air conditioning systems in vocational vehicles, and EPA's proposed nitrous oxide (N_2O) and methane (CH_4) standards for heavy-duty engines. Additionally, NHTSA is addressing misalignment in the Phase 1 standards between EPA and NHTSA to ensure there are no differences in compliance standards between the agencies. In an effort to promote efficiency, the agencies are also proposing to amend their rules to modify reporting requirements, such as the method by which manufacturers submit pre-model, mid-model, and supplemental reports. EPA's proposed HD Phase 2 GHG emission standards are authorized under the Clean Air Act and NHTSA's proposed HD Phase 2 fuel consumption standards authorized under the Energy Independence and Security Act of 2007. These standards would begin with model year 2018 for trailers under EPA standards and 2021 for all of the other heavy-duty vehicle and engine categories. The agencies estimate that the combined standards would reduce CO_2 emissions by approximately 1 billion metric tons and save 1.8 billion barrels of oil over the life of vehicles and engines sold during the Phase 2 program, providing over $200 billion in net societal benefits. As noted, the proposal also includes certain EPA-specific provisions relating to control of emissions of pollutants other than GHGs. EPA is seeking comment on non-GHG emission standards relating to the use of auxiliary power units installed in tractors. In addition, EPA is proposing to clarify the classification of natural gas engines and other gaseous-fueled heavy-duty engines, and is proposing closed crankcase standards for emissions of all pollutants from natural gas heavy-duty engines. EPA is also proposing technical amendments to EPA rules that apply to emissions of non-GHG pollutants from light-duty motor vehicles, marine diesel engines, and other nonroad engines and equipment. Finally, EPA is proposing to require that rebuilt engines installed in new incomplete vehicles meet the emission standards applicable in the year of assembly, including all applicable standards for criteria pollutants.

DATES: Comments on all aspects of this proposal must be received on or before September 11, 2015. Under the Paperwork Reduction Act (PRA), comments on the information collection provisions are best assured of consideration if the Office of Management and Budget (OMB) receives a copy of your comments on or before August 12, 2015.

EPA and NHTSA will announce the public hearing dates and locations for this proposal in a supplemental **Federal Register** document.

ADDRESSES: Submit your comments, identified by Docket ID No. EPA–HQ–OAR–2014–0827 (for EPA's docket) and NHTSA–2014–0132 (for NHTSA's docket) by one of the following methods:

- *Online: www.regulations.gov:* Follow the on-line instructions for submitting comments.
- *Email: a-and-r-docket@epa.gov.*
- *Mail:*

EPA: Air and Radiation Docket and Information Center, Environmental Protection Agency, Mail code: 28221T, 1200 Pennsylvania Ave. NW., Washington, DC 20460.

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

- *Hand Delivery:*

EPA: EPA Docket Center, EPA WJC West Building, Room 3334, 1301 Constitution Ave. NW., Washington, DC 20460. Such deliveries are only accepted during the Docket's normal hours of operation, and special arrangements should be made for deliveries of boxed information.

NHTSA: West Building, Ground Floor, Rm. W12–140, 1200 New Jersey Avenue SE., Washington, DC 20590, between 9 a.m. and 4 p.m. Eastern Time, Monday through Friday, except Federal holidays.

Instructions: EPA and NHTSA have established dockets for this action under Direct your comments to Docket ID No. EPA–HQ–OAR–2014–0827 and/or NHTSA–2014–0132, respectively. See the **SUPPLEMENTARY INFORMATION** section on ''Public Participation'' for more information about submitting written comments.

Docket: All documents in the docket are listed on the *www.regulations.gov* Web site. Although listed in the index, some information is not publicly available, *e.g.,* confidential business information or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically through *www.regulations.gov* or in hard copy at the following locations:

EPA: Air and Radiation Docket and Information Center, EPA Docket Center, EPA/DC, EPA WJC West Building, 1301 Constitution Ave. NW., Room 3334, Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Air Docket is (202) 566–1742.

NHTSA: Docket Management Facility, M–30, U.S. Department of

Transportation, West Building, Ground Floor, Rm. W12–140, 1200 New Jersey Avenue SE., Washington, DC 20590. The telephone number for the docket management facility is (202) 366–9324. The docket management facility is open between 9 a.m. and 5 p.m. Eastern Time, Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT:

EPA: For hearing information or to register, please contact: JoNell Iffland, Office of Transportation and Air Quality, Assessment and Standards Division (ASD), Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; Telephone number: (734) 214–4454; Fax number: (734) 214–4816; Email address: *iffland.jonell@epa.gov*. For all other information related to the rule, please contact: Tad Wysor, Office of Transportation and Air Quality, Assessment and Standards Division (ASD), Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; telephone number: (734) 214–4332; email address: *wysor.tad@epa.gov*.

NHTSA: Ryan Hagen or Analiese Marchesseault, Office of Chief Counsel, National Highway Traffic Safety Administration, 1200 New Jersey Avenue SE., Washington, DC 20590. Telephone: (202) 366–2992; *ryan.hagen@dot.gov* or *analiese.marchesseault@dot.gov*.

SUPPLEMENTARY INFORMATION:

A. Does this action apply to me?

This proposed action would affect companies that manufacture, sell, or import into the United States new heavy-duty engines and new Class 2b through 8 trucks, including combination tractors, all types of buses, vocational vehicles including municipal, commercial, recreational vehicles, and commercial trailers as well as ¾-ton and 1-ton pickup trucks and vans. The heavy-duty category incorporates all motor vehicles with a gross vehicle weight rating of 8,500 lbs or greater, and the engines that power them, except for medium-duty passenger vehicles already covered by the greenhouse gas standards and corporate average fuel economy standards issued for light-duty model year 2017–2025 vehicles. Proposed regulated categories and entities include the following:

Category	NAICS code [a]	Examples of potentially affected entities
Industry	336111	Motor Vehicle Manufacturers, Engine Manufacturers, Truck Manufacturers, Truck Trailer Manufacturers.
	336112	
	333618	
	336120	
	336212	
Industry	541514	Commercial Importers of Vehicles and Vehicle Components.
	811112	
	811198	
Industry	336111	Alternative Fuel Vehicle Converters.
	336112	
	422720	
	454312	
	541514	
	541690	
	811198	

Note:[a] North American Industry Classification System (NAICS).

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely covered by these rules. This table lists the types of entities that the agencies are aware may be regulated by this action. Other types of entities not listed in the table could also be regulated. To determine whether your activities are regulated by this action, you should carefully examine the applicability criteria in the referenced regulations. You may direct questions regarding the applicability of this action to the persons listed in the preceding **FOR FURTHER INFORMATION CONTACT** section.

B. Public Participation

EPA and NHTSA request comment on all aspects of this joint proposed rule. This section describes how you can participate in this process.

(1) How do I prepare and submit comments?

In this joint proposal, there are many issues common to both EPA's and NHTSA's proposals. For the convenience of all parties, comments submitted to the EPA docket will be considered comments submitted to the NHTSA docket, and vice versa. An exception is that comments submitted to the NHTSA docket on NHTSA's Draft Environmental Impact Statement (EIS) will not be considered submitted to the EPA docket. Therefore, the public only needs to submit comments to either one of the two agency dockets, although they may submit comments to both if they so choose. Comments that are submitted for consideration by one agency should be identified as such, and comments that are submitted for consideration by both agencies should be identified as such. Absent such identification, each agency will exercise its best judgment to determine whether a comment is submitted on its proposal.

Further instructions for submitting comments to either EPA or NHTSA docket are described below.

EPA: Direct your comments to Docket ID No. EPA–HQ–OAR–2014–0827. EPA's policy is that all comments received will be included in the public docket without change and may be made available online at *www.regulations.gov*, including any personal information provided, unless the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through *www.regulations.gov* or email. The *www.regulations.gov* Web site is an ''anonymous access'' system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an email comment directly to EPA without going through *www.regulations.gov* your email address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD–ROM you submit. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses. For additional information about EPA's public docket visit the EPA Docket Center homepage at *http://www.epa.gov/epahome/dockets.htm*.

NHTSA: Your comments must be written and in English. To ensure that your comments are correctly filed in the Docket, please include the Docket number NHTSA–2014–0132 in your comments. Your comments must not be more than 15 pages long.[1] NHTSA established this limit to encourage you to write your primary comments in a concise fashion. However, you may attach necessary additional documents to your comments, and there is no limit on the length of the attachments. If you are submitting comments electronically as a PDF (Adobe) file, we ask that the documents submitted be scanned using the Optical Character Recognition (OCR) process, thus allowing the agencies to search and copy certain portions of your submissions.[2] Please note that pursuant to the Data Quality Act, in order for the substantive data to be relied upon and used by the agency, it must meet the information quality standards set forth in the OMB and Department of Transportation (DOT) Data Quality Act guidelines. Accordingly, we encourage you to consult the guidelines in preparing your comments. OMB's guidelines may be accessed at *http://www.whitehouse.gov/omb/fedreg/reproducible.html*. DOT's guidelines may be accessed at *http://www.dot.gov/dataquality.htm*.

(2) Tips for Preparing Your Comments

When submitting comments, please remember to:

• Identify the rulemaking by docket number and other identifying information (subject heading, **Federal Register** date and page number).

• Explain why you agree or disagree, suggest alternatives, and substitute language for your requested changes.

• Describe any assumptions and provide any technical information and/or data that you used.

• If you estimate potential costs or burdens, explain how you arrived at your estimate in sufficient detail to allow for it to be reproduced.

• Provide specific examples to illustrate your concerns, and suggest alternatives.

• Explain your views as clearly as possible, avoiding the use of profanity or personal threats.

• Make sure to submit your comments by the comment period deadline identified in the DATES section above.

(3) How can I be sure that my comments were received?

NHTSA: If you submit your comments by mail and wish Docket Management to notify you upon its receipt of your comments, enclose a self-addressed, stamped postcard in the envelope containing your comments. Upon receiving your comments, Docket Management will return the postcard by mail.

(4) How do I submit confidential business information?

Any confidential business information (CBI) submitted to one of the agencies will also be available to the other agency. However, as with all public comments, any CBI information only needs to be submitted to either one of the agencies' dockets and it will be available to the other. Following are specific instructions for submitting CBI to either agency. If you have any questions about CBI or the procedures for claiming CBI, please consult the persons identified in the FOR FURTHER INFORMATION CONTACT section.

EPA: Do not submit CBI to EPA through *www.regulations.gov* or email. Clearly mark the part or all of the information that you claim to be CBI. For CBI information in a disk or CD ROM that you mail to EPA, mark the outside of the disk or CD ROM as CBI and then identify electronically within the disk or CD ROM the specific information that is claimed as CBI. Information not marked as CBI will be included in the public docket without prior notice. In addition to one complete version of the comment that includes information claimed as CBI, a copy of the comment that does not contain the information claimed as CBI must be submitted for inclusion in the public docket. Information so marked will not be disclosed except in accordance with procedures set forth in 40 CFR part 2.

NHTSA: If you wish to submit any information under a claim of confidentiality, you should submit three copies of your complete submission, including the information you claim to be confidential business information, to the Chief Counsel, NHTSA, at the address given above under FOR FURTHER INFORMATION CONTACT. When you send a comment containing confidential business information, you should include a cover letter setting forth the information specified in our confidential business information regulation.[3]

In addition, you should submit a copy from which you have deleted the claimed confidential business information to the Docket by one of the methods set forth above.

(5) How can I read the comments submitted by other people?

You may read the materials placed in the docket for this document (*e.g.,* the comments submitted in response to this document by other interested persons) at any time by going to *http://www.regulations.gov*. Follow the online instructions for accessing the dockets. You may also read the materials at the EPA Docket Center or NHTSA Docket Management Facility by going to the street addresses given above under ADDRESSES.

(6) How do I participate in the public hearings?

EPA and NHTSA will announce the public hearing dates and locations for this proposal in a supplemental **Federal Register** document. At all hearings, both agencies will accept comments on the rulemaking, and NHTSA will also accept comments on the EIS.

If you would like to present testimony at the public hearings, we ask that you notify EPA and NHTSA contact persons listed in the FOR FURTHER INFORMATION CONTACT section at least ten days before the hearing. Once EPA and NHTSA learn how many people have registered to speak at the public hearing, we will allocate an appropriate amount of time to each participant. For planning purposes, each speaker should anticipate speaking for approximately ten minutes, although we may need to adjust the time for each speaker if there is a large turnout. We suggest that you bring copies of your statement or other material for EPA and NHTSA panels. It would also be helpful if you send us a copy of your statement or other materials before the hearing. To accommodate as many speakers as possible, we prefer that speakers not use technological aids (*e.g.,* audio-visuals, computer slideshows). However, if you plan to do so, you must notify the contact persons in the FOR FURTHER INFORMATION CONTACT section above. You also must make arrangements to provide your presentation or any other

[1] See 49 CFR 553.21.

[2] Optical character recognition (OCR) is the process of converting an image of text, such as a scanned paper document or electronic fax file, into computer-editable text.

[3] See 49 CFR part 512.

aids to EPA and NHTSA in advance of the hearing in order to facilitate set-up. In addition, we will reserve a block of time for anyone else in the audience who wants to give testimony. The agencies will assume that comments made at the hearings are directed to the proposed rule unless commenters specifically reference NHTSA's EIS in oral or written testimony.

The hearing will be held at a site accessible to individuals with disabilities. Individuals who require accommodations such as sign language interpreters should contact the persons listed under **FOR FURTHER INFORMATION CONTACT** section above no later than ten days before the date of the hearing.

EPA and NHTSA will conduct the hearing informally, and technical rules of evidence will not apply. We will arrange for a written transcript of the hearing and keep the official record of the hearing open for 30 days to allow you to submit supplementary information. You may make arrangements for copies of the transcript directly with the court reporter.

C. Did EPA conduct a peer review before issuing this notice?

This regulatory action is supported by influential scientific information. Therefore, EPA conducted a peer review consistent with OMB's Final Information Quality Bulletin for Peer Review. As described in Section II.C.3, a peer review of updates to the vehicle simulation model (GEM) for the proposed Phase 2 standards has been completed. This version of GEM is based on the model used for the Phase 1 rule, which was peer-reviewed by a panel of four independent subject matter experts (from academia and a national laboratory). The peer review report and the agency's response to the peer review comments are available in Docket ID No. EPA–HQ–OAR–2014–0827.

D. Executive Summary

(1) Commitment to Greenhouse Gas Emission Reductions and Vehicle Fuel Efficiency

As part of the Climate Action Plan announced in June 2013,[4] the President directed the Environmental Protection Agency (EPA) and the Department of Transportation's (DOT) National Highway Traffic Safety Administration (NHTSA) to set the next round of standards to reduce greenhouse gas (GHG) emissions and improve fuel efficiency for medium- and heavy-duty vehicles. More than 70 percent of the oil used in the United States and 28 percent of GHG emissions come from the transportation sector, and since 2009 EPA and NHTSA have worked with industry and states to develop ambitious, flexible standards for both the fuel economy and GHG emissions of light-duty vehicles and the fuel efficiency and GHG emissions of heavy-duty vehicles.[5] [6] The standards proposed here (referred to as Phase 2) would build on the light-duty vehicle standards spanning model years 2011 to 2025 and on the initial phase of standards (referred to as Phase 1) for new medium and heavy-duty vehicles (MDVs and HDVs) and engines in model years 2014 to 2018. Throughout every stage of development for these programs, EPA and NHTSA (collectively, the agencies, or ''we'') have worked in close partnership not only with one another, but with the vehicle manufacturing industry, environmental community leaders, and the State of California among other entities to create a single, effective set of national standards.

Through two previous rulemakings, EPA and NHTSA have worked with the auto industry to develop new fuel economy and GHG emission standards for light-duty vehicles. Taken together, the light-duty vehicle standards span model years 2011 to 2025 and are the first significant improvement in fuel economy in approximately two decades. Under the final program, average new car and light truck fuel economy is expected to double by 2025.[7] This is projected to save consumers $1.7 trillion at the pump—roughly $8,200 per vehicle for a MY2025 vehicle—reducing oil consumption by 2.2 million barrels a day in 2025 and slashing GHG emissions by 6 billion metric tons over the lifetime of the vehicles sold during this period.[8] These fuel economy standards are already delivering savings for American drivers. Between model years 2008 and 2013, the unadjusted average test fuel economy of new passenger cars and light trucks sold in the United States has increased by about four miles per gallon. Altogether, light-duty vehicle fuel economy standards finalized after 2008 have already saved nearly one billion gallons of fuel and avoided more than 10 million tons of carbon dioxide emissions.[9]

Similarly, EPA and NHTSA have previously developed joint GHG emission and fuel efficiency standards for MDVs and HDVs. Prior to these Phase 1 standards, heavy-duty trucks and buses—from delivery vans to the largest tractor-trailers—were required to meet pollution standards for soot and smog-causing air pollutants, but no requirements existed for the fuel efficiency or carbon pollution from these vehicles.[10] By 2010, total fuel consumption and GHG emissions from MDVs and HDVs had been growing, and these vehicles accounted for 23 percent of total U.S. transportation-related GHG emissions.[11] In August 2011, the agencies finalized the groundbreaking Phase 1 standards for new MDVs and HDVs in model years 2014 through 2018. This program, developed with support from the trucking and engine industries, the State of California, Environment Canada, and leaders from the environmental community, set standards that are expected to save a projected 530 million barrels of oil and reduce carbon emissions by about 270 million metric tons, representing one of the most significant programs available to reduce domestic emissions of GHGs.[12] The Phase 1 program, as well as the many additional actions called for in the President's 2013 Climate Action Plan [13] including this Phase 2 rulemaking, not only result in meaningful decreases in GHG emissions, but support—indeed are critical for—United States leadership to encourage other countries to also achieve meaningful GHG reductions.

This proposal builds on our commitment to robust collaboration with stakeholders and the public. It follows an expansive and thorough outreach effort in which the agencies gathered input, data and views from many interested stakeholders, involving over 200 meetings with heavy-duty vehicle and engine manufacturers, technology suppliers, trucking fleets, truck drivers, dealerships, environmental organizations, and state agencies. As with the previous light-duty rules and the heavy-duty Phase 1 rule, the agencies have consulted

[4] The White House, The President's Climate Action Plan (June, 2013). *http://www.whitehouse.gov/share/climate-action-plan.*

[5] The White House, Improving the Fuel Efficiency of American Trucks—Bolstering Energy Security, Cutting Carbon Pollution, Saving Money and Supporting Manufacturing Innovation (Feb. 2014), 2.

[6] U.S. Environmental Protection Agency. 2014. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012. EPA 430–R–14–003. Mobile sources emitted 28 percent of all U.S. GHG emissions in 2012. Available at *http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Main-Text.pdf.*

[7] *Id.*

[8] *Id.*

[9] *Id.* at 3.

[10] *Id.*

[11] *Id.*

[12] *Id.* at 4.

[13] The President's Climate Action Plan calls for GHG-cutting actions including, for example, reducing carbon emissions from power plants and curbing hydrofluorocarbon and methane emissions.

frequently with the California Air Resources Board staff during the development of this Phase 2 proposal, given California's unique ability among the states to adopt their own GHG standards for on-highway engines and vehicles. The agencies look forward to feedback and ongoing conversation following the release of this proposed rule from all stakeholders—including through planned public hearings, written comments, and other opportunities for input.

(2) Overview of Phase 1 Medium- and Heavy-Duty Vehicle Standards

The President's direction to EPA and NHTSA to develop GHG emission and fuel efficiency standards for MDVs and HDVs resulted in the agencies' promulgation of the Phase 1 program in 2011, which covers new trucks and heavy vehicles in model years 2014 to 2018. The Phase 1 program includes specific standards for combination tractors, heavy-duty pickup trucks and vans, and vocational vehicles, and includes separate standards for both vehicles and engines. The program offers extensive flexibility, allowing manufacturers to reach standards through average fleet calculations, a mix of technologies, and the use of various credit and banking programs.

The Phase 1 program was developed through close consultation with industry and other stakeholders, resulting in standards tailored to the specifics of each different class of vehicles and engines.

- Heavy-duty combination tractors. Combination tractors—semi trucks that typically pull trailers—are regulated under nine subcategories based on weight class, cab type, and roof height. These vehicles represent approximately two-thirds of all fuel consumption and GHG emissions from MDVs and HDVs.
- Heavy-duty pickup trucks and vans. Heavy-duty pickup and van standards are based on a ''work factor'' attribute that combines a vehicle's payload, towing capabilities, and the presence of 4-wheel drive. These vehicles represent about 15 percent of the fuel consumption and GHG emissions from MDVs and HDVs.
- Vocational vehicles. Specialized vocational vehicles, which consist of a very wide variety of truck and bus types (*e.g.,* delivery, refuse, utility, dump, cement, transit bus, shuttle bus, school bus, emergency vehicles, and recreational vehicles) are regulated in three subcategories based on engine classification. These vehicles represent approximately 20 percent of the fuel consumption and GHG emissions from MDVs and HDVs. The Phase 1 program includes EPA GHG standards for recreational vehicles, but not NHTSA fuel efficiency standards.[14]
- Heavy-duty engines. In addition to vehicle types, the Phase 1 rule has separate standards for heavy-duty engines, to assure they contribute to the overall vehicle reductions in fuel consumption and GHG emissions.

The Phase 1 standards are premised on utilization of immediately available technologies. The Phase 1 program provides flexibilities that facilitate compliance. These flexibilities help provide sufficient lead time for manufacturers to make necessary technological improvements and reduce the overall cost of the program, without compromising overall environmental and fuel consumption objectives. The primary flexibility provisions are an engine averaging, banking, and trading (ABT) program and a vehicle ABT program. These ABT programs allow for emission and/or fuel consumption credits to be averaged, banked, or traded within each of the regulatory subcategories. However, credits are not allowed to be transferred across subcategories.

The Phase 1 program is projected to save 530 million barrels of oil and avoid 270 million metric tons of GHG emissions.[15] At the same time, the program is projected to produce $50 billion in fuel savings, and net societal benefits of $49 billion. Today, the Phase 1 fuel efficiency and GHG reduction standards are already reducing GHG emissions and U.S. oil consumption, and producing fuel savings for America's trucking industry. The market appears to be very accepting of the new technology, and the agencies have seen no evidence of ''pre-buy'' effects in response to the standards.

(3) Overview of Proposed Phase 2 Medium- and Heavy-Duty Vehicle Standards

The Phase 2 GHG and fuel efficiency standards for MDVs and HDVs are a critical next step in improving fuel efficiency and reducing GHG. The proposed Phase 2 standards carry forward our commitment to meaningful collaboration with stakeholders and the public, as they build on more than 200 meetings with manufacturers, suppliers, trucking fleets, dealerships, state air quality agencies, non-governmental organizations (NGOs), and other stakeholders to identify and understand the opportunities and challenges involved with this next level of fuel saving technology. These meetings have been invaluable to the agencies, enabling the development of a proposal that appropriately balances all potential impacts and effectively minimizes the possibility of unintended consequences.

Phase 2 would include technology-advancing standards that would phase in over the long-term (through model year 2027) to result in an ambitious, yet achievable program that would allow manufacturers to meet standards through a mix of different technologies at reasonable cost. The Phase 2 standards would maintain the underlying regulatory structure developed in the Phase 1 program, such as the general categorization of MDVs and HDVs and the separate standards for vehicles and engines. However, the Phase 2 program would build on and advance Phase 1 in a number of important ways including: Basing standards not only on currently available technologies but also on utilization of technologies now under development or not yet widely deployed while providing significant lead time to assure adequate time to develop, test, and phase in these controls; developing standards for trailers; further encouraging innovation and providing flexibility; including vehicles produced by small business manufacturers; incorporating enhanced test procedures that (among other things) allow individual drivetrain and powertrain performance to be reflected in the vehicle certification process; and using an expanded and improved compliance simulation model.

- Strengthening standards to account for ongoing technological advancements. Relative to the baseline as of the end of Phase 1, the proposed standards (labeled Alternative 3 or the ''preferred alternative'' throughout this proposal) would achieve vehicle fuel savings of up to 8 percent and 24 percent, depending on the vehicle category. While costs are higher than for Phase 1, benefits greatly exceed costs, and payback periods are short, meaning that consumers will see substantial net savings over the vehicle lifetime. Payback is estimated at about two years for tractors and trailers, about five years for vocational vehicles, and about three years for heavy-duty pickups and vans. The agencies are further proposing to phase in these MY 2027 standards with interim standards for model years 2021 and 2024 (and for certain types of trailers, EPA is proposing model year 2018 phase-in standards as well).

[14] The proposed Phase 2 program would also include NHTSA recreational vehicle fuel efficiency standards.

[15] The White House, Improving the Fuel Efficiency of American Trucks—Bolstering Energy Security, Cutting Carbon Pollution, Saving Money and Supporting Manufacturing Innovation (Feb. 2014), 4.

In addition to the proposed standards, the agencies are considering another alternative (Alternative 4), which would achieve the same performance as the proposed standards 2–3 years earlier, leading to overall reductions in fuel use and greenhouse gas emissions. The agencies believe Alternative 4 has the potential to be the maximum feasible and appropriate alternative; however, based on the evidence currently before us, EPA and NHTSA have outstanding questions regarding relative risks and benefits of Alternative 4 due to the timeframe envisioned by that alternative. The agencies are proposing Alternative 3 based on their analyses and projections, and taking into account the agencies' respective statutory considerations. The comments that the agencies receive on this proposal will be instrumental in helping us determine standards that are appropriate (for EPA) and maximum feasible (for NHTSA), given the discretion that both agencies have under our respective statutes. Therefore, the agencies have presented different options and raised specific questions throughout the proposed rule, focusing in particular on better understanding the perspectives on the feasible adoption rates of different technologies, considering associated costs and necessary lead time.

- Setting standards for trailers for the first time. In addition to retaining the vehicle and engine categories covered in the Phase 1 program, which include semi tractors, heavy-duty pickup trucks and work vans, vocational vehicles, and separate standards for heavy-duty engines, the Phase 2 standards propose fuel efficiency and GHG emission standards for trailers used in combination with tractors. Although the agencies are not proposing standards for all trailer types, the majority of new trailers would be covered.
- Encouraging technological innovation while providing flexibility and options for manufacturers. For each category of HDVs, the standards would set performance targets that allow manufacturers to achieve reductions through a mix of different technologies and leave manufacturers free to choose any means of compliance. For tractors and vocational vehicles, enhanced test procedures and an expanded and improved compliance simulation model enable the proposed vehicle standards to encompass more of the complete vehicle and to account for engine, transmission and driveline improvements than the Phase 1 program. With the addition of the powertrain and driveline to the compliance model, representative drive cycles and vehicle baseline configurations become critically important to assure the standards promote technologies that improve real world fuel efficiency and GHG emissions. This proposal updates drive cycles and vehicle configurations to better reflect real world operation. For tractor standards, for example, different combinations of improvements like advanced aerodynamics, engine improvements and waste-heat recovery, automated transmission, and lower rolling resistance tires and automatic tire inflation can be used to meet standards. Additionally, the agencies' analyses indicate that this proposal should have no adverse impact on vehicle or engine safety.
- Providing flexibilities to help minimize effect on small businesses. All small businesses are exempt from the Phase 1 standards. The agencies are proposing to regulate small business entities under Phase 2 (notably certain trailer manufacturers), but have conducted extensive proceedings pursuant to Section 609 of the Regulatory Flexibility Act, and otherwise have engaged in extensive consultation with stakeholders, and developed a proposed approach to provide targeted flexibilities geared toward helping small businesses comply with the Phase 2 standards. Specifically, the agencies are proposing to delay all new requirements by one year and simplify certification requirements for small businesses, and are further proposing additional specific flexibilities adapted to particular types of trailers.

SUMMARY OF THE PROPOSED PHASE 2 MEDIUM- AND HEAVY-DUTY VEHICLE RULE IMPACTS TO FUEL CONSUMPTION, GHG EMISSIONS, BENEFITS AND COSTS OVER THE LIFETIME OF MODEL YEARS 2018–2029, BASED ON ANALYSIS METHOD A[a b c]

	3%	7%
Fuel Reductions (billion gallons)	72–77	
GHG Reductions (MMT, CO_2eq)	974–1034	
Pre-Tax Fuel Savings ($billion)	165–175	89–94
Discounted Technology Costs ($billion)	25–25.4	16.8 -17.1
Value of reduced emissions ($billion)	70.1–73.7	52.9–55.6
Total Costs ($billion)	30.5–31.1	20.0–20.5
Total Benefits ($billion)	261–276	156–165
Net Benefits ($billion)	231–245	136–144

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Range reflects two reference case assumptions, one that projects very little improvement in new vehicle fuel efficiency absent new standards, and the second that projects more significant improvements in vehicle fuel efficiency absent new standards.

[c] Benefits and net benefits (including those in the 7% discount rate column) use the 3 percent average SCC–CO_2 value applied only to CO_2 emissions; GHG reductions include CO_2, CH_4, N_2O and HFC reductions.

SUMMARY OF THE PROPOSED PHASE 2 MEDIUM- AND HEAVY-DUTY VEHICLE ANNUAL FUEL AND GHG REDUCTIONS, PROGRAM COSTS, BENEFITS AND NET BENEFITS IN CALENDAR YEARS 2035 AND 2050, BASED ON ANALYSIS METHOD B[a]

	2035	2050
Fuel Reductions (Billion Gallons)	9.3	13.4
GHG Reduction (MMT, CO_2eq)	127.1	183.4
Vehicle Program Costs (including Maintenance; Billions of 2012$)	− $6.0	− $7.1
Fuel Savings (Pre-Tax; Billions of 2012$)	$37.2	$57.5
Benefits (Billions of 2012$)	$20.5	$32.9

SUMMARY OF THE PROPOSED PHASE 2 MEDIUM- AND HEAVY-DUTY VEHICLE ANNUAL FUEL AND GHG REDUCTIONS, PROGRAM COSTS, BENEFITS AND NET BENEFITS IN CALENDAR YEARS 2035 AND 2050, BASED ON ANALYSIS METHOD B [a]—Continued

	2035	2050
Net Benefits (Billions of 2012$)	$51.7	$83.2

Note:
[a] Benefits and net benefits use the 3 percent average SCC-CO_2 value applied only to CO_2 emissions; GHG reductions include CO_2, CH_4, N_2O and HFC reductions; values reflect the preferred alternative relative to the less dynamic baseline (a reference case that projects very little improvement in new vehicle fuel economy absent new standards.

SUMMARY OF THE PROPOSED PHASE 2 MEDIUM- AND HEAVY-DUTY VEHICLE PROGRAM EXPECTED PER-VEHICLE FUEL SAVINGS, GHG EMISSION REDUCTIONS, AND COST FOR KEY VEHICLE CATEGORIES, BASED ON ANALYSIS METHOD B [a]

	MY 2021	MY 2024	MY 2027
Maximum Vehicle Fuel Savings and Tailpipe GHG Reduction (%)			
Tractors	13	20	24
Trailers [b]	4	6	8
Vocational Vehicles	7	11	16
Pickups/Vans	2.5	10	16
Per Vehicle Cost ($) [c] (% Increase in Typical Vehicle Price) [d]			
Tractors	$6,710 (7%)	$9,940 (10%)	$11,680 (12%)
Trailers	$900 (4%)	$1,010 (4%)	$1,170 (5%)
Vocational Vehicles	$1,150 (2%)	$1,770 (3%)	$3,380 (5%)
Pickups/Vans	$520 (1%)	$950 (2%)	$1,340 (3%)

Notes:
[a] Note that the proposed EPA standards for some categories of box trailers begin in model year 2018; values reflect the preferred alternative relative to the less dynamic baseline (a reference case that projects very little improvement in new vehicle fuel economy absent new standards.
[b] All engine costs are included.
[c] For this table, we use a minimum vehicle price today of $100,000 for tractors, $25,000 for trailers, $70,000 for vocational vehicles and $40,000 for HD pickups/vans.

PAYBACK PERIODS FOR MY2027 VEHICLES UNDER THE PROPOSED STANDARDS, BASED ON ANALYSIS METHOD B

[Payback occurs in the year shown; using 7% discounting]

	Proposed standards
Tractors/Trailers	2nd
Vocational Vehicles	6th
Pickups/Vans	3rd

(4) Issues Addressed in This Proposed Rule

This proposed rule contains extensive discussion of the background, elements, and implications of the proposed Phase 2 program. Section I includes information on the MDV and HDV industry, related regulatory and non-regulatory programs, summaries of Phase 1 and Phase 2 programs, costs and benefits of the proposed standards, and relevant statutory authority for EPA and NHTSA. Section II discusses vehicle simulation, engine standards, and test procedures. Sections III, IV, V, and VI detail the proposed standards for combination tractors, trailers, vocational vehicles, and heavy-duty pickup trucks and vans. Sections VII and VIII discuss aggregate GHG impacts, fuel consumption impacts, climate impacts, and impacts on non-GHG emissions. Section IX evaluates the economic impacts of the proposed standards. Sections X, XI, and XII present the alternatives analyses, consideration of natural gas vehicles, and the agencies' initial response to recommendations from the Academy of Sciences. Finally, Sections XIII and XIV discuss the changes that the proposed Phase 2 rules would have on Phase 1 standards and other regulatory provisions. In addition to this preamble, the agencies have also prepared a joint Draft Regulatory Impact Analysis (DRIA) which is available on our respective Web sites and in the public docket for this rulemaking which provides additional data, analysis and discussion of the proposed standards and the alternatives analyzed by the agencies. We request comment on all aspects of this proposed rulemaking, including the DRIA.

Table of Contents

I. Overview

A. Background

This background and summary of the proposed Phase 2 GHG emissions and fuel efficiency standards includes an overview of the heavy-duty truck industry and related regulatory and non-regulatory programs, a summary of the Phase 1 GHG emissions and fuel efficiency program, a summary of the proposed Phase 2 standards and requirements, a summary of the costs and benefits of the proposed Phase 2 standards, discussion of EPA and NHTSA statutory authorities, and other issues.

For purposes of this preamble, the terms ''heavy-duty'' or ''HD'' are used to apply to all highway vehicles and engines that are not within the range of light-duty passenger cars, light-duty trucks, and medium-duty passenger vehicles (MDPV) covered by separate GHG and Corporate Average Fuel Economy (CAFE) standards.[16] They do not include motorcycles. Thus, in this rulemaking, unless specified otherwise, the heavy-duty category incorporates all vehicles with a gross vehicle weight rating above 8,500 lbs, and the engines that power them, except for MDPVs.[17] [18]

Consistent with the President's direction, over the past two years as we have developed this proposal, the agencies have met on an on-going basis with a very large number of diverse stakeholders. This includes meetings, and in many cases site visits, with truck, trailer, and engine manufacturers; technology supplier companies and their trade associations (*e.g.,* transmissions, drive lines, fuel systems, turbochargers, tires, catalysts, and many others); line haul and vocational trucking firms and trucking associations; the trucking industries owner-operator association; truck dealerships and dealers associations; trailer manufacturers and their trade association; non-governmental organizations (NGOs, including environmental NGOs, national security NGOs, and consumer advocacy NGOs); state air quality agencies; manufacturing labor unions; and many other stakeholders. In particular, NHTSA and EPA have consulted on an on-going basis with the California Air Resources Board (CARB) over the past two years as we have developed the Phase 2 proposal. In addition, CARB staff and managers have also participated with EPA and NHTSA in meetings with

[16] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule, 77 FR 62623, October 15, 2012.

[17] The CAA defines heavy-duty as a truck, bus or other motor vehicles with a gross vehicle weight rating exceeding 6,000 lbs (CAA section 202(b)(3)). The term HD as used in this action refers to a subset of these vehicles and engines.

[18] The Energy Independence and Security Act of 2007 requires NHTSA to set standards for commercial medium- and heavy-duty on-highway vehicles, defined as on-highway vehicles with a GVWR of 10,000 lbs or more, and work trucks, defined as vehicles with a GVWR between 8,500 and 10,000 lbs and excluding medium duty passenger vehicles.

many external stakeholders, in particular with vehicle OEMs and technology suppliers.[19]

NHTSA and EPA staff also participated in a large number of technical and policy conferences over the past two years related to the technological, economic, and environmental aspects of the heavy-duty trucking industry. The agencies also met with regulatory counterparts from several other nations who either have already or are considering establishing fuel consumption or GHG requirements, including outreach with representatives from the governments of Canada, the European Commission, Japan, and China.

These comprehensive outreach actions by the agencies provided us with information to assist in our identification of potential technologies that can be used to reduce heavy-duty GHG emissions and improve fuel efficiency. The outreach has also helped the agencies to identify and understand the opportunities and challenges involved with the proposed standards for the heavy-duty trucks, trailers, and engines detailed in this preamble, including time needed for implementation of various technologies and potential costs and fuel savings. The scope of this outreach effort to gather input for the proposal included well over 200 meetings with stakeholders. These meetings and conferences have been invaluable to the agencies. We believe they have enabled us to develop this proposal in such a way as to appropriately balance all of the potential impacts, to minimize the possibility of unintended consequences, and to ensure that we are requesting comment on a wide range of issues that can inform the final rule.

(1) Brief Overview of the Heavy-Duty Truck Industry

The heavy-duty sector is diverse in several respects, including the types of manufacturing companies involved, the range of sizes of trucks and engines they produce, the types of work for which the trucks are designed, and the regulatory history of different subcategories of vehicles and engines. The current heavy-duty fleet encompasses vehicles from the ''18-wheeler'' combination tractors one sees on the highway to the largest pickup trucks and vans, as well as vocational vehicles covering a range between these extremes. Together, the HD sector spans a wide range of vehicles with often specialized form and function. A primary indicator of the diversity among heavy-duty trucks is the range of load-carrying capability across the industry. The heavy-duty truck sector is often subdivided by vehicle weight classifications, as defined by the vehicle's gross vehicle weight rating (GVWR), which is a measure of the combined curb (empty) weight and cargo carrying capacity of the truck.[20] Table I–1 below outlines the vehicle weight classifications commonly used for many years for a variety of purposes by businesses and by several Federal agencies, including the Department of Transportation, the Environmental Protection Agency, the Department of Commerce, and the Internal Revenue Service.

TABLE I–1—VEHICLE WEIGHT CLASSIFICATION

Class	2b	3	4	5	6	7	8
GVWR (lb)	8,501–10,000	10,001–14,000	14,001–16,000	16,001–19,500	19,501–26,000	26,001–33,000	>33,000

In the framework of these vehicle weight classifications, the heavy-duty truck sector refers to ''Class 2b'' through ''Class 8'' vehicles and the engines that power those vehicles.[21]

Unlike light-duty vehicles, which are primarily used for transporting passengers for personal travel, heavy-duty vehicles fill much more diverse operator needs. Heavy-duty pickup trucks and vans (Classes 2b and 3) are used chiefly as work trucks and vans, and as shuttle vans, as well as for personal transportation, with an average annual mileage in the range of 15,000 miles. The rest of the heavy-duty sector is used for carrying cargo and/or performing specialized tasks. ''Vocational'' vehicles, which may span Classes 2b through 8, vary widely in size, including smaller and larger van trucks, utility ''bucket'' trucks, tank trucks, refuse trucks, urban and over-the-road buses, fire trucks, flat-bed trucks, and dump trucks, among others. The annual mileage of these vehicles is as varied as their uses, but for the most part tends to fall in between heavy-duty pickups/vans and the large combination tractors, typically from 15,000 to 150,000 miles per year.

Class 7 and 8 combination tractor-trailers—some equipped with sleeper cabs and some not—are primarily used for freight transportation. They are sold as tractors and operate with one or more trailers that can carry up to 50,000 lbs or more of payload, consuming significant quantities of fuel and producing significant amounts of GHG emissions. Together, Class 7 and 8 tractors and trailers account for approximately two-thirds of the heavy-duty sector's total CO_2 emissions and fuel consumption. Trailer designs vary significantly, reflecting the wide variety of cargo types. However, the most common types of trailers are box vans (dry and refrigerated), which are a focus of this Phase 2 rulemaking. The tractor-trailers used in combination applications can and frequently do travel more than 150,000 miles per year and can operate for 20–30 years.

EPA and NHTSA have designed our respective proposed standards in careful consideration of the diversity and complexity of the heavy-duty truck industry, as discussed in Section I.B.

(2) Related Regulatory and Non-Regulatory Programs

(a) History of EPA's Heavy-Duty Regulatory Program and Impacts of Greenhouse Gases on Climate Change

This subsection provides an overview of the history of EPA's heavy-duty regulatory program and impacts of greenhouse gases on climate change.

(i) History of EPA's Heavy-Duty Regulatory Program

Since the 1980s, EPA has acted several times to address tailpipe emissions of criteria pollutants and air toxics from heavy-duty vehicles and engines. During the last two decades these programs have primarily

[19] Vehicle chassis manufacturers are known in this industry as original equipment manufacturers or OEMs.

[20] GVWR describes the maximum load that can be carried by a vehicle, including the weight of the vehicle itself. Heavy-duty vehicles (including those designed for primary purposes other than towing) also have a gross combined weight rating (GCWR), which describes the maximum load that the vehicle can haul, including the weight of a loaded trailer and the vehicle itself.

[21] Class 2b vehicles manufactured as passenger vehicles (Medium Duty Passenger Vehicles, MDPVs) are covered by the light-duty GHG and fuel economy standards and therefore are not addressed in this rulemaking.

addressed emissions of particulate matter (PM) and the primary ozone precursors, hydrocarbons (HC) and oxides of nitrogen (NO_X). These programs, which have successfully achieved significant and cost-effective reductions in emissions and associated health and welfare benefits to the nation, were an important basis of the Phase 1 program. See *e.g.* 66 FR 5002, 5008, and 5011–5012 (January 18, 2001) (detailing substantial public health benefits of controls of criteria pollutants from heavy-duty diesel engines, including bringing areas into attainment with primary (public health) PM NAAQS, or contributing substantially to such attainment); *National Petrochemical Refiners Association* v. *EPA,* 287 F.3d 1130, 1134 (D.C. Cir. 2002) (referring to the ''dramatic reductions'' in criteria pollutant emissions resulting from those on-highway heavy-duty engine standards, and upholding all of the standards).

As required by the Clean Air Act (CAA), the emission standards implemented by these programs include standards that apply at the time that the vehicle or engine is sold and continue to apply in actual use. EPA's overall program goal has always been to achieve emissions reductions from the complete vehicles that operate on our roads. The agency has often accomplished this goal for many heavy-duty truck categories by regulating heavy-duty engine emissions. A key part of this success has been the development over many years of a well-established, representative, and robust set of engine test procedures that industry and EPA now use routinely to measure emissions and determine compliance with emission standards. These test procedures in turn serve the overall compliance program that EPA implements to help ensure that emissions reductions are being achieved. By isolating the engine from the many variables involved when the engine is installed and operated in a HD vehicle, EPA has been able to accurately address the contribution of the engine alone to overall emissions.

(ii) Impacts of Greenhouse Gases on Climate Change

In 2009, the EPA Administrator issued the document known as the Endangerment Finding under CAA Section 202(a)(1).[22] In the Endangerment Finding, which focused on public health and public welfare impacts within the United States, the Administrator found that elevated concentrations of GHG emissions in the atmosphere may reasonably be anticipated to endanger public health and welfare of current and future generations. See also *Coalition for Responsible Regulation* v. *EPA,* 684 F.3d 102, 117–123 (D.C. Cir. 2012) (upholding the endangerment finding in all respects). The following sections summarize the key information included in the Endangerment Finding.

Climate change caused by human emissions of GHGs threatens public health in multiple ways. By raising average temperatures, climate change increases the likelihood of heat waves, which are associated with increased deaths and illnesses. While climate change also increases the likelihood of reductions in cold-related mortality, evidence indicates that the increases in heat mortality will be larger than the decreases in cold mortality in the United States. Compared to a future without climate change, climate change is expected to increase ozone pollution over broad areas of the U.S., including in the largest metropolitan areas with the worst ozone problems, and thereby increase the risk of morbidity and mortality. Other public health threats also stem from projected increases in intensity or frequency of extreme weather associated with climate change, such as increased hurricane intensity, increased frequency of intense storms and heavy precipitation. Increased coastal storms and storm surges due to rising sea levels are expected to cause increased drownings and other adverse health impacts. Children, the elderly, and the poor are among the most vulnerable to these climate-related health effects. See also 79 FR 75242 (December 17, 2014) (climate change, and temperature increases in particular, likely to increase O3 (Ozone) pollution ''over broad areas of the U.S., including the largest metropolitan areas with the worst O3 problems, increas[ing] the risk of morbidity and mortality'').

Climate change caused by human emissions of GHGs also threatens public welfare in multiple ways. Climate changes are expected to place large areas of the country at serious risk of reduced water supplies, increased water pollution, and increased occurrence of extreme events such as floods and droughts. Coastal areas are expected to face increased risks from storm and flooding damage to property, as well as adverse impacts from rising sea level, such as land loss due to inundation, erosion, wetland submergence and habitat loss. Climate change is expected to result in an increase in peak electricity demand, and extreme weather from climate change threatens energy, transportation, and water resource infrastructure. Climate change may exacerbate ongoing environmental pressures in certain settlements, particularly in Alaskan indigenous communities. Climate change also is very likely to fundamentally rearrange U.S. ecosystems over the 21st century. Though some benefits may balance adverse effects on agriculture and forestry in the next few decades, the body of evidence points towards increasing risks of net adverse impacts on U.S. food production, agriculture and forest productivity as temperature continues to rise. These impacts are global and may exacerbate problems outside the U.S. that raise humanitarian, trade, and national security issues for the U.S. See also 79 FR 75382 (December 17, 2014) (welfare effects of O3 increases due to climate change, with emphasis on increased wildfires).

As outlined in Section VIII.A. of the 2009 Endangerment Finding, EPA's approach to providing the technical and scientific information to inform the Administrator's judgment regarding the question of whether GHGs endanger public health and welfare was to rely primarily upon the recent, major assessments by the U.S. Global Change Research Program (USGCRP), the Intergovernmental Panel on Climate Change (IPCC), and the National Research Council (NRC) of the National Academies. These assessments addressed the scientific issues that EPA was required to examine, were comprehensive in their coverage of the GHG and climate change issues, and underwent rigorous and exacting peer review by the expert community, as well as rigorous levels of U.S. government review. Since the administrative record concerning the Endangerment Finding closed following EPA's 2010 Reconsideration Denial, a number of such assessments have been released. These assessments include the IPCC's 2012 ''Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation'' (SREX) and the 2013–2014 Fifth Assessment Report (AR5), the USGCRP's 2014 ''Climate Change Impacts in the United States'' (Climate Change Impacts), and the NRC's 2010 ''Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean'' (Ocean Acidification), 2011 ''Report on Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia'' (Climate Stabilization Targets), 2011 ''National Security Implications for U.S. Naval

[22] ''Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act,'' *74 FR 66496* (December 15, 2009) (''Endangerment Finding'').

Forces'' (National Security Implications), 2011 ''Understanding Earth's Deep Past: Lessons for Our Climate Future'' (Understanding Earth's Deep Past), 2012 ''Sea Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future'', 2012 ''Climate and Social Stress: Implications for Security Analysis'' (Climate and Social Stress), and 2013 ''Abrupt Impacts of Climate Change'' (Abrupt Impacts) assessments.

EPA has reviewed these new assessments and finds that the improved understanding of the climate system they present strengthens the case that GHG emissions endanger public health and welfare.

In addition, these assessments highlight the urgency of the situation as the concentration of CO_2 in the atmosphere continues to rise. Absent a reduction in emissions, a recent National Research Council of the National Academies assessment projected that concentrations by the end of the century would increase to levels that the Earth has not experienced for millions of years.[23] In fact, that assessment stated that ''the magnitude and rate of the present greenhouse gas increase place the climate system in what could be one of the most severe increases in radiative forcing of the global climate system in Earth history.'' [24] What this means, as stated in another NRC assessment, is that:

> Emissions of carbon dioxide from the burning of fossil fuels have ushered in a new epoch where human activities will largely determine the evolution of Earth's climate. Because carbon dioxide in the atmosphere is long lived, it can effectively lock Earth and future generations into a range of impacts, some of which could become very severe. Therefore, emission reductions choices made today matter in determining impacts experienced not just over the next few decades, but in the coming centuries and millennia.[25]

Moreover, due to the time-lags inherent in the Earth's climate, the Climate Stabilization Targets assessment notes that the full warming from any given concentration of CO_2 reached will not be realized for several centuries.

The recently released USGCRP ''National Climate Assessment'' [26] emphasizes that climate change is already happening now and it is happening in the United States. The assessment documents the increases in some extreme weather and climate events in recent decades, the damage and disruption to infrastructure and agriculture, and projects continued increases in impacts across a wide range of peoples, sectors, and ecosystems.

These assessments underscore the urgency of reducing emissions now: Today's emissions will otherwise lead to raised atmospheric concentrations for thousands of years, and raised Earth system temperatures for even longer. Emission reductions today will benefit the public health and public welfare of current and future generations.

Finally, it should be noted that the concentration of carbon dioxide in the atmosphere continues to rise dramatically. In 2009, the year of the Endangerment Finding, the average concentration of carbon dioxide as measured on top of Mauna Loa was 387 parts per million.[27] The average concentration in 2013 was 396 parts per million. And the monthly concentration in April of 2014 was 401 parts per million, the first time a monthly average has exceeded 400 parts per million since record keeping began at Mauna Loa in 1958, and for at least the past 800,000 years according to ice core records.[28]

(b) The NHTSA and EPA Light-Duty National GHG and Fuel Economy Program

On May 7, 2010, EPA and NHTSA finalized the first-ever National Program for light-duty cars and trucks, which set GHG emissions and fuel economy standards for model years 2012–2016 (see 75 FR 25324). More recently, the agencies adopted even stricter standards for model years 2017 and later (77 FR 62624, October 15, 2012). The agencies have used the light-duty National Program as a model for the HD National Program in several respects. This is most apparent in the case of heavy-duty pickups and vans, which are similar to the light-duty trucks addressed in the light-duty National Program both technologically as well as in terms of how they are manufactured (*i.e.,* the same company often makes both the vehicle and the engine, and several light-duty manufacturers also manufacture HD pickups and vans).[29] For HD pickups and vans, there are close parallels to the light-duty program in how the agencies have developed our respective heavy-duty standards and compliance structures. However, HD pickups and vans are true work vehicles that are designed for much higher towing and payload capabilities than are light-duty pickups and vans. The technologies applied to light-duty trucks are not all applicable to heavy-duty pickups and vans at the same adoption rates, and the technologies often produce a lower percent reduction in CO_2 emissions and fuel consumption when used in heavy-duty vehicles. Another difference between the light-duty and the heavy-duty standards is that each agency adopts heavy-duty standards based on attributes other than vehicle footprint, as discussed below.

Due to the diversity of the remaining HD vehicles, there are fewer parallels with the structure of the light-duty program. However, the agencies have maintained the same collaboration and coordination that characterized the development of the light-duty program throughout the Phase 1 rulemaking and the continued efforts for Phase 2. Most notably, as with the light-duty program, manufacturers would continue to be able to design and build vehicles to meet a closely coordinated, harmonized national program, and to avoid unnecessarily duplicative testing and compliance burdens. In addition, the averaging, banking, and trading provisions in the HD program, although structurally different from those of the light-duty program, serve the same purpose, which is to allow manufacturers to achieve large reductions in fuel consumption and emissions while providing a broad mix of products to their customers. The agencies have also worked closely with CARB to provide harmonized national standards.

(c) EPA's SmartWay Program

EPA's voluntary SmartWay Transport Partnership program encourages businesses to take actions that reduce fuel consumption and CO_2 emissions while cutting costs by working with the shipping, logistics, and carrier communities to identify low carbon strategies and technologies across their transportation supply chains. SmartWay provides technical information, benchmarking and tracking tools, market incentives, and partner recognition to facilitate and accelerate the adoption of these strategies. Through the SmartWay program and its related technology assessment center, EPA has worked closely with truck and trailer manufacturers and truck fleets over the last ten years to develop test

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[23] National Research Council, Understanding Earth's Deep Past, p. 1

[24] Id., p.138.

[25] National Research Council, Climate Stabilization Targets, p. 3.

[26] U.S. Global Change Research Program, Climate Change Impacts in the United States: The Third National Climate Assessment, May 2014 Available at *http://nca2014.globalchange.gov/*.

[27] *ftp://aftp.cmdl.noaa.gov/products/trends/co2/co2_annmean_mlo.txt*.

[28] *http://www.esrl.noaa.gov/gmd/ccgg/trends/*.

[29] This is more broadly true for heavy-duty pickup trucks than vans because every manufacturer of heavy-duty pickup trucks also makes light-duty pickup trucks, while only some heavy-duty van manufacturers also make light-duty vans.

procedures to evaluate vehicle and component performance in reducing fuel consumption and has conducted testing and has established test programs to verify technologies that can achieve these reductions. SmartWay partners have demonstrated these new and emerging technologies in their business operations, adding to the body of technical data and information that EPA can disseminate to industry, researchers and other stakeholders. Over the last several years, EPA has developed hands-on experience testing the largest heavy-duty trucks and trailers and evaluating improvements in tire and vehicle aerodynamic performance. In developing the Phase 1 program, the agencies drew from this testing and from the SmartWay experience. In the same way, the agencies benefitted from SmartWay in developing the proposed Phase 2 trailer program.

(d) The State of California

California has established ambitious goals for reducing GHG emissions from heavy-duty vehicles and engines as part of an overall plan to reduce GHG emissions from the transportation sector in California.[30] Heavy-duty vehicles are responsible for one-fifth of the total GHG emissions from transportation sources in California. In the past several years the California Air Resources Board (CARB) has taken a number of actions to reduce GHG emissions from heavy-duty vehicles and engines. For example, in 2008, the CARB adopted regulations to reduce GHG emissions from heavy-duty tractors that pull box-type trailers through improvements in tractor and trailer aerodynamics and the use of low rolling resistance tires.[31] The tractors and trailers subject to the CARB regulation are required to use SmartWay certified tractors and trailers, or retrofit their existing fleet with SmartWay verified technologies, consistent with California's state authority to regulate both new and in-use vehicles. Recently, in December 2013, CARB adopted regulations that establish its own parallel Phase 1 program with standards consistent with EPA Phase 1 standards. On December 5, 2014, California's Office of Administrative Law approved CARB's adoption of the Phase 1 standards, with an effective date of December 5, 2014.[32] Complementary to its regulatory efforts, CARB and other California agencies are investing significant public capital through various incentive programs to accelerate fleet turnover and stimulate technology innovation within the heavy-duty vehicle market (*e.g.,* Air Quality Improvement, Carl Moyer, Loan Incentives, Lower-Emission School Bus and Goods Movement Emission Reduction Programs).[33] And, recently, California Governor Jerry Brown established a target of up to 50 percent petroleum reduction by 2030.

In addition to California's efforts to reduce GHG emissions that contribute to climate change, California also faces unique air quality challenges as compared to many other regions of the United States. Many areas of the state are classified as non-attainment for both the ozone and particulate matter National Ambient Air Quality Standards (NAAQS) with California having the nation's only two ''Extreme'' ozone non-attainment airsheds (the San Joaquin Valley and South Coast Air Basins).[34] By 2016, California must submit to EPA its Clean Air Act State Implementation Plans (SIPs) that demonstrate how the 2008 ozone and 2006 $PM_{2.5}$ NAAQS will be met by Clean Air Act deadlines. Extreme ozone areas must attain the 2008 ozone NAAQS by no later than 2032 and $PM_{2.5}$ moderate areas must attain the 2006 $PM_{2.5}$ standard by 2021 or, if reclassified to serious, by 2025.

Heavy-duty vehicles are responsible today for one-third of the state's oxides of nitrogen (NO_X) emissions. California has estimated that the state's South Coast Air Basin will need nearly a 90 percent reduction in heavy-duty vehicle NO_X emissions by 2032 from 2010 levels to attain the 2008 NAAQS for ozone. Additionally, on November 25, 2014, EPA issued a proposal to strengthen the ozone NAAQS. If a change to the ozone NAAQS is finalized, California and other areas of the country will need to identify and implement measures to reduce NO_X as needed to complement Federal emission reduction measures. While this section is focused on California's regulatory programs and air quality needs, EPA recognizes that other states and local areas are concerned about the challenges of reducing NO_X and attaining, as well as maintaining, the ozone NAAQS (further discussed in Section VIII.D.1 below).

In order to encourage the use of lower NO_X emitting new heavy-duty vehicles in California, in 2013 CARB adopted a voluntary low NO_X emission standard for heavy-duty engines.[35] In addition, in 2013 CARB awarded a major new research contract to Southwest Research Institute to investigate advanced technologies that could reduce heavy-duty vehicle NO_X emissions well below the current EPA and CARB standards.

California has long had the unique ability among states to adopt its own separate new motor vehicle standards per Section 209 of the Clean Air Act (CAA). Although section 209(a) of the CAA expressly preempts states from adopting and enforcing standards relating to the control of emissions from new motor vehicles or new motor vehicle engines (such as state controls for new heavy-duty engines and vehicles) CAA section 209(b) directs EPA to waive this preemption under certain conditions. Under the waiver process set out in CAA Section 209(b), EPA has granted CARB a waiver for its initial heavy-duty vehicle GHG regulation.[36] Even with California's ability under the CAA to establish its own emission standards, EPA and CARB have worked closely together over the past several decades to largely harmonize new vehicle criteria pollutant standard programs for heavy-duty engines and heavy-duty vehicles. In the past several years EPA and NHTSA also consulted with CARB in the development of the Federal light-duty vehicle GHG and CAFE rulemakings for the 2012–2016 and 2017–2025 model years.

As discussed above, California operates under state authority to establish its own new heavy-duty vehicle and engine emission standards, including standards for CO_2, methane, N_2O, and hydrofluorocarbons. EPA recognizes this independent authority, and we also recognize the potential

[30] See *http://www.arb.ca.gov/cc/cc.htm* for details on the California Air Resources Board climate change actions, including a discussion of Assembly Bill 32, and the Climate Change Scoping Plan developed by CARB, which includes details regarding CARB's future goals for reducing GHG emissions from heavy-duty vehicles.

[31] See *http://www.arb.ca.gov/msprog/truckstop/trailers/trailers.htm* for a summary of CARB's ''Tractor-Trailer Greenhouse Gas Regulation''.

[32] See *http://www.arb.ca.gov/regact/2013/hdghg2013/hdghg2013.htm* for details regarding CARB's adoption of the Phase 1 standards.

[33] See *http://www.arb.ca.gov/ba/fininfo.htm* for detailed descriptions of CARB's mobile source incentive programs. Note that EPA works to support CARB's heavy-duty incentive programs through the West Coast Collaborative (*http://westcoastcollaborative.org/*) and the Clean Air Technology Initiative (*http://www.epa.gov/region09/cleantech/*).

[34] See *http://www.epa.gov/airquality/greenbk/index.html* for more information on EPA's nonattainment designations.

[35] See *http://www.arb.ca.gov/regact/2013/hdghg2013/hdghg2013.htm* for a description of the CARB optional reduced NO_X emission standards for on-road heavy-duty engines.

[36] *See* EPA's waiver of CARB's heavy-duty tractor-trailer greenhouse gas regulation applicable to new 2011 through 2013 model year Class 8 tractors equipped with integrated sleeper berths (sleeper-cab tractors) and 2011 and subsequent model year dry-can and refrigerated-van trailers that are pulled by such tractors on California highways at 79 FR 46256 (August 7, 2014).

benefits for the regulated industry if the Federal Phase 2 standards could result in a single, National Program that would meet the NHTSA and EPA's statutory requirements to set appropriate and maximum feasible standards, and also be equivalent to potential future new heavy-duty vehicle and engine GHG standards established by CARB (addressing the same model years as addressed by the final Federal Phase 2 program and requiring the same technologies).

Similarly, CARB has expressed support in the past for a Federal heavy-duty Phase 2 program that would produce significant GHG reductions both at the Federal level and in California that could enable CARB to adopt the same standards at the state level. This is similar to CARB's approach for the Federal heavy-duty Phase 1 program, and with past EPA criteria pollutant standards for heavy-duty vehicles and engines. In order to further the opportunity for maintaining coordinated Federal and California standards in the Phase 2 timeframe (as well as to benefit from different technical expertise and perspective), NHTSA and EPA have consulted on an on-going basis with CARB over the past two years as we have developed the Phase 2 proposal. The agencies' technical staff have shared information on technology cost, technology effectiveness, and feasibility with the CARB staff. We have also received information from CARB on these same topics. EPA and NHTSA have also shared preliminary results from several of our modeling exercises with CARB as we examined different potential levels of stringency for the Phase 2 program. In addition, CARB staff and managers have also participated with EPA and NHTSA in meetings with many external stakeholders, in particular with vehicle OEMs and technology suppliers.

In addition to information on GHG emissions, CARB has also kept EPA and NHTSA informed of the state's need to consider opportunities for additional NO_X emission reductions from heavy-duty vehicles. CARB has asked the agencies to consider opportunities in the Heavy-Duty Phase 2 rulemaking to encourage or incentivize further NO_X emission reductions, in addition to the petroleum and GHG reductions which would come from the Phase 2 standards. When combined with the Phase 1 standards, the technologies the agencies are projecting to be used to meet the proposed GHG emission and fuel efficiency standards would be expected to reduce NO_X emissions by over 450,000 tons in 2050 (see Section VIII).

EPA and NHTSA believe that through this information sharing and dialog we will enhance the potential for the Phase 2 program to result in a National Program that can be adopted not only by the Federal agencies, but also by the State of California, given the strong interest from the regulated industry for a harmonized State and Federal program.

The agencies will continue to seek input from CARB, and from all stakeholders, throughout this rulemaking.

(e) Environment Canada

On March 13, 2013, Environment Canada (EPA's Canadian counterpart) published its own regulations to control GHG emissions from heavy-duty vehicles and engines, beginning with MY 2014. These regulations are closely aligned with EPA's Phase 1 program to achieve a common set of North American standards. Environment Canada has expressed its intention to amend these regulations to further limit emissions of greenhouse gases from new on-road heavy-duty vehicles and their engines for post-2018 MYs. As with the development of the current regulations, Environment Canada is committed to continuing to work closely with EPA to maintain a common Canada-United States approach to regulating GHG emissions for post-2018 MY vehicles and engines. This approach will build on the long history of regulatory alignment between the two countries on vehicle emissions pursuant to the Canada-United States Air Quality Agreement.[37] Environment Canada has also been of great assistance during the development of this Phase 2 proposal. In particular, Environment Canada supported aerodynamic testing, and conducted chassis dynamometer emissions testing.

(f) Recommendations of the National Academy of Sciences

In April 2010 as mandated by Congress in the Energy Independence and Security Act of 2007 (EISA), the National Research Council (NRC) under the National Academy of Sciences (NAS) issued a report to NHTSA and to Congress evaluating medium- and heavy-duty truck fuel efficiency improvement opportunities, titled ''Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-duty Vehicles.'' That NAS report was far reaching in its review of the technologies that were available and that might become available in the future to reduce fuel consumption from medium- and heavy-duty vehicles. In presenting the full range of technical opportunities, the report included technologies that may not be available until 2020 or even further into the future. The report provided not only a valuable list of off the shelf technologies from which the agencies drew in developing the Phase 1 program, but also provided useful information the agencies have considered when developing this second phase of regulations.

[37] *http://www.ijc.org/en_/Air_Quality__Agreement.*

In April 2014, the NAS issued another report: ''Reducing the Fuel Consumption and Greenhouse Gas Emissions of Medium and Heavy-Duty Vehicles, Phase Two, First Report.'' This study outlines a number of recommendations to the U.S. Department of Transportation and NHTSA on technical and policy matters to consider when addressing the fuel efficiency of our nation's medium- and heavy-duty vehicles. In particular, this report provided recommendations with respect to:

- The Greenhouse Gas Emission Model (GEM) simulation tool used by the agencies to assess compliance with vehicle standards
- Regulation of trailers
- Natural gas-fueled engines and vehicles
- Data collection on in-use operation

As described in Sections II, IV, and XII, the agencies are proposing to incorporate many of these recommendations into this proposed Phase 2 program, especially those recommendations relating to the GEM simulation tool and to trailers.

B. Summary of Phase 1 Program

(1) EPA Phase 1 GHG Emission Standards and NHTSA Phase 1 Fuel Consumption Standards

The EPA Phase 1 GHG mandatory standards commenced in MY 2014 and include increased stringency for standards applicable to MY 2017 and later MY vehicles and engines. NHTSA's fuel consumption standards are voluntary for MYs 2014 and 2015, due to lead time requirements in EISA, and apply on a mandatory basis thereafter. They also increase in stringency for MY 2017. Both agencies have allowed voluntary early compliance starting in MY 2013 and encouraged manufacturers' participation through credit incentives.

Given the complexity of the heavy-duty industry, the agencies divided the industry into three discrete categories for purposes of setting our respective Phase 1 standards—combination tractors, heavy-duty pickups and vans, and vocational vehicles—based on the relative degree of homogeneity among trucks within each category. The Phase 1 rule also include separate standards for the engines that power combination tractors and vocational vehicles. For each regulatory category, the agencies adopted related but distinct program approaches reflecting the specific challenges in these segments. In the following paragraphs, we summarize briefly EPA's final GHG emission standards and NHTSA's final fuel consumption standards for the three regulatory categories of heavy-duty vehicles and for the engines powering vocational vehicles and tractors. See Sections III, V, and VI for additional details on the Phase 1 standards. To respect differences in design and typical uses that drive different technology solutions, the agencies segmented each regulatory class into subcategories. The category-specific structure enabled the agencies to set standards that appropriately reflect the technology available for each regulatory subcategory of vehicles and the engines for use in each type of vehicle. The Phase 1 program also provided several flexibilities, as summarized in Section I.B(3).

The agencies are proposing to base the Phase 2 standards on test procedures that differ from those used for Phase 1, including the revised GEM simulation tool. Significant revisions to GEM are discussed in Section II and the draft RIA Chapter 4, and other test procedures are discussed further in the draft RIA Chapter 3. It is important to note that due to these test procedure changes, the Phase 1 standards and the proposed Phase 2 standards are not directly comparable in an absolute sense. In particular, the proposed revisions to the 55 mph and 65 mph highway cruise cycles for tractors and vocational vehicles have the effect of making the cycles more challenging (albeit more representative of actual driving conditions). We are not proposing to apply these revisions to the Phase 1 program because doing so would significantly change the stringency of the Phase 1 standards, for which manufacturers have already developed engineering plans and are now producing products to meet. Moreover, the agencies intend such changes to address a broader range of technologies not part of the projected compliance path for use in Phase 1.

(a) Class 7 and 8 Combination Tractors

Class 7 and 8 combination tractors and their engines contribute the largest portion of the total GHG emissions and fuel consumption of the heavy-duty sector, approximately two-thirds, due to their large payloads, their high annual miles traveled, and their major role in national freight transport. These vehicles consist of a cab and engine (tractor or combination tractor) and a detachable trailer. The primary manufacturers of combination tractors in the United States are Daimler Trucks North America, Navistar, Volvo/Mack, and PACCAR. Each of the tractor manufacturers and Cummins (an independent engine manufacturer) also produce heavy-duty engines used in tractors. The Phase 1 standards require manufacturers to reduce GHG emissions and fuel consumption for these vehicles and engines, which we expect them to do through improvements in aerodynamics and tires, reductions in tractor weight, reduction in idle operation, as well as engine-based efficiency improvements.[38]

The Phase 1 tractor standards differ depending on gross vehicle weight rating (GVWR) (*i.e.,* whether the truck is Class 7 or Class 8), the height of the roof of the cab, and whether it is a ''day cab'' or a ''sleeper cab.'' The agencies created nine subcategories within the Class 7 and 8 combination tractor category reflecting combinations of these attributes. The agencies set Phase 1 standards for each of these subcategories beginning in MY 2014, with more stringent standards following in MY 2017. The standards represent an overall fuel consumption and CO_2 emissions reduction up to 23 percent from the tractors and the engines installed in them when compared to a baseline MY 2010 tractor and engine.

For Phase 1, manufacturers demonstrate compliance with the tractor CO_2 and fuel consumption standards using a vehicle simulation tool described in Section II. The tractor inputs to the simulation tool in Phase 1 are the aerodynamic performance, tire rolling resistance, vehicle speed limiter, automatic engine shutdown, and weight reduction. The agencies have verified, through our own confirmatory testing, that the values inputs into the model by manufacturers are generally correct. Prior to and after adopting the Phase 1 standards, the agencies worked with manufacturers to minimize impacts of this process on their normal business practices.

In addition to the final Phase 1 tractor-based standards for CO_2, EPA adopted a separate standard to reduce leakage of hydrofluorocarbon (HFC) refrigerant from cabin air conditioning (A/C) systems from combination tractors, to apply to the tractor manufacturer. This HFC leakage standard is independent of the CO_2 tractor standard. Manufacturers can choose technologies from a menu of leak-reducing technologies sufficient to comply with the standard, as opposed to using a test to measure performance. Given that HFC leakage does not relate to fuel efficiency, NHTSA did not adopt corresponding HFC standards.

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

Heavy-duty vehicles with a GVWR between 8,501 and 10,000 lb are classified as Class 2b motor vehicles. Heavy-duty vehicles with a GVWR between 10,001 and 14,000 lb are classified as Class 3 motor vehicles. Class 2b and Class 3 heavy-duty vehicles (referred to in these rules as ''HD pickups and vans'') together emit about 15 percent of today's GHG emissions from the heavy-duty vehicle sector.[39]

The majority of HD pickups and vans are ¾-ton and 1-ton pickup trucks, 12- and 15-passenger vans,[40] and large work vans that are sold by vehicle manufacturers as complete vehicles, with no secondary manufacturer making substantial modifications prior to registration and use. These vehicles can also be sold as cab-complete vehicles (*i.e.,* incomplete vehicles that include complete or nearly complete cabs that are sold to secondary manufacturers). The majority of heavy-duty pickups and vans are produced by companies with major light-duty markets in the United States. Furthermore, the technologies available to reduce fuel consumption and GHG emissions from this segment are similar to the technologies used on light-duty pickup trucks, including both engine efficiency improvements (for gasoline and diesel engines) and vehicle efficiency improvements. For these reasons, EPA and NHTSA concluded that it was appropriate to adopt GHG standards, expressed as grams per mile, and fuel consumption standards, expressed as gallons per 100 miles, for HD pickups and vans based on the whole vehicle (including the engine), consistent with the way these vehicles

[38] We note although the standards' stringency is predicated on use of certain technologies, and the agencies' assessed the cost of the rule based on the cost of use of those technologies, the standards can be met by any means. Put another way, the rules create a performance standard, and do not mandate any particular means of achieving that level of performance.

[39] EPA MOVES Model, *http://www.epa.gov/otaq/models/moves/index.htm.*

[40] Note that 12-passenger vans are subject to the light-duty standards as medium-duty passenger vehicles (MDPVs) and are not subject to this proposal.

have been regulated by EPA for criteria pollutants and also consistent with the way their light-duty counterpart vehicles are regulated by NHTSA and EPA. This complete vehicle approach adopted by both agencies for HD pickups and vans was consistent with the recommendations of the NAS Committee in its 2010 Report.

For the light-duty GHG and fuel economy standards, the agencies based the emissions and fuel economy targets on vehicle footprint (the wheelbase times the average track width). For those standards, passenger cars and light trucks with larger footprints are assigned higher GHG and lower fuel economy target levels reflecting their inherent tendency to consume more fuel and emit more GHGs per mile. For HD pickups and vans, the agencies believe that setting standards based on vehicle attributes is appropriate, but have found that a work-based metric would be a more appropriate attribute than the footprint attribute utilized in the light-duty vehicle rulemaking, given that work-based measures such as towing and payload capacities are critical elements of these vehicles' functionality. EPA and NHTSA therefore adopted standards for HD pickups and vans based on a ''work factor'' attribute that combines their payload and towing capabilities, with an added adjustment for 4-wheel drive vehicles.

Each manufacturer's fleet average Phase 1 standard is based on production volume-weighting of target standards for all vehicles, which in turn are based on each vehicle's work factor. These target standards are taken from a set of curves (mathematical functions), with separate curves for gasoline and diesel.[41] However, both gasoline and diesel vehicles in this category are included in a single averaging set. EPA phased in the CO_2 standards gradually starting in the 2014 MY, at 15–20–40–60–100 percent of the MY 2018 standards stringency level in MYs 2014–2015–2016–2017–2018, respectively. The phase-in takes the form of a set of target curves, with increasing stringency in each MY.

NHTSA allowed manufacturers to select one of two fuel consumption standard alternatives for MYs 2016 and later. The first alternative defined individual gasoline vehicle and diesel vehicle fuel consumption target curves that will not change for MYs 2016–2018, and are equivalent to EPA's 67–67–67–100 percent target curves in MYs 2016–2017–2018–2019, respectively. The second alternative defined target curves that are equivalent to EPA's 40–60–100 percent target curves in MYs 2016–2017–2018, respectively. NHTSA allowed manufacturers to opt voluntarily into the NHTSA HD pickup and van program in MYs 2014 or 2015 at target curves equivalent to EPA's target curves. If a manufacturer chose to opt in for one category, they would be required to opt in for all categories. In other words a manufacturer would be unable to opt in for Class 2b vehicles, but opt out for Class 3 vehicles.

EPA also adopted an alternative phase-in schedule for manufacturers wanting to have stable standards for model years 2016–2018. The standards for heavy-duty pickups and vans, like those for light-duty vehicles, are expressed as set of target standard curves, with increasing stringency in each model year. The final EPA standards for 2018 (including a separate standard to control air conditioning system leakage) represent an average per-vehicle reduction in GHG emissions of 17 percent for diesel vehicles and 12 percent for gasoline vehicles (relative to pre-control baseline vehicles). The NHTSA standard will require these vehicles to achieve up to about 15 percent reduction in fuel consumption and greenhouse gas emissions by MY 2018 (relative to pre-control baseline vehicles). Manufacturers demonstrate compliance based on entire vehicle chassis certification using the same duty cycles used to demonstrate compliance with criteria pollutant standards.

(c) Class 2b–8 Vocational Vehicles

Class 2b–8 vocational vehicles include a wide variety of vehicle types, and serve a vast range of functions. Some examples include service for urban delivery, refuse hauling, utility service, dump, concrete mixing, transit service, shuttle service, school bus, emergency, motor homes, and tow trucks. In Phase 1, we defined Class 2b–8 vocational vehicles as all heavy-duty vehicles that are not included in either the heavy-duty pickup and van category or the Class 7 and 8 tractor category. EPA's and NHTSA's Phase 1 standards for this vocational vehicle category generally apply at the chassis manufacturer level. Class 2b–8 vocational vehicles and their engines emit approximately 20 percent of the GHG emissions and burn approximately 21 percent of the fuel consumed by today's heavy-duty truck sector.[42]

The Phase 1 program for vocational vehicles has vehicle standards and separate engine standards, both of which differ based on the weight class of the vehicle into which the engine will be installed. The vehicle weight class groups mirror those used for the engine standards—Classes 2b–5 (light heavy-duty or LHD in EPA regulations), Classes 6 & 7 (medium heavy-duty or MHD in EPA regulations) and Class 8 (heavy heavy-duty or HHD in EPA regulations). Manufacturers demonstrate compliance with the Phase 1 vocational vehicle CO_2 and fuel consumption standards using a vehicle simulation tool described in Section II. The Phase 1 program for vocational vehicles limited the simulation tool inputs to tire rolling resistance. The model assumes the use of a typical representative, compliant engine in the simulation, resulting in one overall value for CO_2 emissions and one for fuel consumption.

Engines used in vocational vehicles are subject to separate Phase 1 engine-based standards. Optional certification paths, for EPA and NHTSA, are also provided to enhance the flexibilities for vocational vehicles. Manufacturers producing spark-ignition (or gasoline) cab-complete or incomplete vehicles weighing over 14,000 lbs GVWR and below 26,001 lbs GVWR have the option to certify to the complete vehicle standards for heavy-duty pickup trucks and vans rather than using the separate engine and chassis standards for vocational vehicles.

(d) Engine Standards

The agencies established separate Phase 1 performance standards for the engines manufactured for use in vocational vehicles and Class 7 and 8 tractors.[43] These engine standards vary depending on engine size linked to intended vehicle service class. EPA's engine-based CO_2 standards and NHTSA's engine-based fuel consumption standards are being implemented using EPA's existing test procedures and regulatory structure for criteria pollutant emissions from heavy-duty engines.

The agencies also finalized a regulatory alternative whereby a manufacturer, for an interim period of the 2014–2016 MYs, would have the option to comply with a unique standard based on a three percent reduction from an individual engine model's own 2011 MY baseline level.[44]

[41] As explained in Section XII, EPA is proposing to recodify the Phase 1 requirements for pickups and vans from 40 CFR 1037.104 into 40 CFR part 86, which is also the regulatory part that applies for light-duty vehicles.

[42] EPA MOVES model, *http://www.epa.gov/otaq/models/moves/index.htm.*

[43] See 76 FR 57114 explaining why NHTSA's authority under the Energy Independence and Safety Act includes authority to establish separate engine standards.

[44] See 76 FR 57144.

(e) Manufacturers Excluded From the Phase 1 Standards

Phase 1 temporarily deferred greenhouse gas emissions and fuel consumption standards for any manufacturers of heavy-duty engines, manufacturers of combination tractors, and chassis manufacturers for vocational vehicles that meet the ''small business'' size criteria set by the Small Business Administration (SBA). 13 CFR 121.201 defines a small business by the maximum number of employees; for example, this is currently 1,000 for heavy-duty vehicle manufacturing and 750 for engine manufacturing. In order to utilize this exemption, qualifying small businesses must submit a declaration to the agencies. See Section I.F.(1)(b) for a summary of how Phase 2 would apply for small businesses.

The agencies stated that they would consider appropriate GHG and fuel consumption standards for these entities as part of a future regulatory action. This includes both U.S.-based and foreign small-volume heavy-duty manufacturers.

(2) Costs and Benefits of the Phase 1 Program

Overall, EPA and NHTSA estimated that the Phase 1 HD National Program will cost the affected industry about $8 billion, while saving vehicle owners fuel costs of nearly $50 billion over the lifetimes of MY 2014–2018 vehicles. The agencies also estimated that the combined standards will reduce CO_2 emissions by about 270 million metric tons and save about 530 million barrels of oil over the life of MY 2014 to 2018 vehicles. The agencies estimated additional monetized benefits from CO_2 reductions, improved energy security, reduced time spent refueling, as well as possible disbenefits from increased driving accidents, traffic congestion, and noise. When considering all these factors, we estimated that Phase 1 of the HD National Program will yield $49 billion in net benefits to society over the lifetimes of MY 2014–2018 vehicles.

EPA estimated the benefits of reduced ambient concentrations of particulate matter and ozone resulting from the Phase 1 program to range from $1.3 to $4.2 billion in 2030.[45]

In total, we estimated the combined Phase 1 standards will reduce GHG emissions from the U.S. heavy-duty fleet by approximately 76 million metric tons of CO_2-equivalent annually by 2030. In its Environmental Impact Statement for the Phase 1 rule, NHTSA also quantified and/or discussed other potential impacts of the program, such as the health and environmental impacts associated with changes in ambient exposures to toxic air pollutants and the benefits associated with avoided non-CO_2 GHGs (methane, nitrous oxide, and HFCs).

(3) Phase 1 Program Flexibilities

As noted above, the agencies adopted numerous provisions designed to give manufacturers a degree of flexibility in complying with the Phase 1 standards. These provisions, which are essentially identical in structure and function in NHTSA's and EPA's regulations, enabled the agencies to consider overall standards that are more stringent and that will become effective sooner than we could consider with a more rigid program, one in which all of a manufacturer's similar vehicles or engines would be required to achieve the same emissions or fuel consumption levels, and at the same time.[46]

Phase 1 included four primary types of flexibility: Averaging, banking, and trading (ABT) provisions; early credits; advanced technology credits (including hybrid powertrains); and innovative technology credit provisions. The ABT provisions were patterned on existing EPA and NHTSA ABT programs (including the light-duty GHG and fuel economy standards) and will allow a vehicle manufacturer to reduce CO_2 emission and fuel consumption levels further than the level of the standard for one or more vehicles to generate ABT credits. The manufacturer can use those credits to offset higher emission or fuel consumption levels in the same averaging set, ''bank'' the credits for later use, or ''trade'' the credits to another manufacturer. As also noted above, for HD pickups and vans, we adopted a fleet averaging system very similar to the light-duty GHG and CAFE fleet averaging system. In both programs, manufacturers are allowed to carry-forward deficits for up to three years without penalty.

The agencies provided in the ABT programs flexibility for situations in which a manufacturer is unable to avoid a negative credit balance at the end of the year. In such cases, manufacturers are not considered to be out of compliance unless they are unable to make up the difference in credits by the end of the third subsequent model year.

In total, the Phase 1 program divides the heavy-duty sector into 19 subcategories of vehicles. These subcategories are grouped into 9 averaging sets to provide greater opportunities in leveraging compliance. For tractors and vocational vehicles, the fleet averaging sets are Classes 2b through 5, Classes 6 and 7, and Class 8 weight classes. For engines, the fleet averaging sets are gasoline engines, light heavy-duty diesel engines, medium heavy-duty diesel engines, and heavy heavy-duty diesel engines. Complete HD pickups and vans (both spark-ignition and compression-ignition) are the final fleet averaging set.

As noted above, the agencies included a restriction on averaging, banking, and trading of credits between the various regulatory subcategories by defining three HD vehicle averaging sets: Light heavy-duty (Classes 2b–5); medium heavy-duty (Class 6–7); and heavy heavy-duty (Class 8). This allows the use of credits between vehicles within the same weight class. This means that a Class 8 day cab tractor can exchange credits with a Class 8 high roof sleeper tractor but not with a smaller Class 7 tractor. Also, a Class 8 vocational vehicle can exchange credits with a Class 8 tractor. However, we did not allow trading between engines and chassis. We similarly allowed for trading among engine categories only within an averaging set, of which there are four: Spark-ignition engines, compression-ignition light heavy-duty engines, compression-ignition medium heavy-duty engines, and compression-ignition heavy heavy-duty engines.

In addition to ABT, the other primary flexibility provisions in the Phase 1 program involve opportunities to generate early credits, advanced technology credits (including for use of hybrid powertrains), and innovative technology credits.[47] For the early credits and advanced technology credits, the agencies adopted a 1.5 × multiplier, meaning that manufacturers would get 1.5 credits for each early credit and each advanced technology credit. In addition, advanced technology credits for Phase 1 can be used anywhere within the heavy-duty sector (including both vehicles and engines). Put another way, as a means of promoting this promising technology,

[45] **Note:** These calendar year benefits do not represent the same time frame as the model year lifetime benefits described above, so they are not additive.

[46] NHTSA explained that it has greater flexibility in the HD program to include consideration of credits and other flexibilities in determining appropriate and feasible levels of stringency than it does in the light-duty CAFE program. *Cf.* 49 U.S.C. 32902(h), which applies to light-duty CAFE but not heavy-duty fuel efficiency under 49 U.S.C. 32902(k).

[47] Early credits are for engines and vehicles certified before EPA standards became mandatory, advanced technology credits are for hybrids and/or Rankine cycle engines, and innovative technology credits are for other technologies not in the 2010 fleet whose benefits are not reflected using the Phase 1 test procedures.

the Phase 1 rule does not restrict averaging or trading by averaging set in this instance.

For other vehicle or engine technologies that can reduce CO_2 and fuel consumption, but for which there do not yet exist established methods for quantifying reductions, the agencies wanted to encourage the development of such innovative technologies, and therefore adopted special ''innovative technology'' credits. These innovative technology credits apply to technologies that are shown to produce emission and fuel consumption reductions that are not adequately recognized on the Phase 1 test procedures and that were not yet in widespread use in the heavy-duty sector before MY 2010. Manufacturers need to quantify the reductions in fuel consumption and CO_2 emissions that the technology is expected to achieve, above and beyond those achieved on the existing test procedures. As with ABT, the use of innovative technology credits is allowed only among vehicles and engines of the same defined averaging set generating the credit, as described above. The credit multiplier likewise does not apply for innovative technology credits.

(4) Implementation of Phase 1

Manufacturers have already begun complying with the Phase 1 standards. In some cases manufacturers voluntarily chose to comply early, before compliance was mandatory. The Phase 1 rule allows manufacturers to generate credits for such early compliance. The market appears to be very accepting of the new technology, and the agencies have seen no evidence of ''pre-buy'' effects in response to the standards. In fact sales have been higher in recent years than they were before Phase 1 began. Moreover, manufacturers' compliance plans are taking advantage of the Phase 1 flexibilities, and we have yet to see significant non-compliance with the standards.

(5) Litigation on Phase 1 Rule

The D.C. Circuit recently rejected all challenges to the agencies' Phase 1 regulations. The court did not reach the merits of the challenges, holding that none of the petitioners had standing to bring their actions, and that a challenge to NHTSA's denial of a rulemaking petition could only be brought in District Court. See *Delta Construction Co.* v. *EPA,* 783 F. 3d 1291 (D.C. Cir. 2015), U.S. App. LEXIS 6780, F.3d (D.C. Cir. April 24, 2015).

C. Summary of the Proposed Phase 2 Standards and Requirements

The agencies are proposing new standards that build on and enhance existing Phase 1 standards, as well as proposing the first ever standards for certain trailers used in combination with heavy-duty tractors. Taken together, the proposed Phase 2 program would comprise a set of largely technology-advancing standards that would achieve greater GHG and fuel consumption savings than the Phase 1 program. As described in more detail in the following sections, the agencies are proposing these standards because, based on the information available at this time, we believe they would best match our respective statutory authorities when considered in the context of available technology, feasible reductions of emissions and fuel consumption, costs, lead time, safety, and other relevant factors. The agencies request comment on all aspects of our feasibility analysis including projections of feasible market adoption rates and technological effectiveness for each technology.

The proposed Phase 2 standards would represent a more technology-forcing [48] approach than the Phase 1 approach, predicated on use of both off-the-shelf technologies and emerging technologies that are not yet in widespread use. The agencies are proposing standards for MY 2027 that would likely require manufacturers to make extensive use of these technologies. For existing technologies and technologies in the final stages of development, we project that manufacturers would likely apply them to nearly all vehicles, excluding those specific vehicles with applications or uses that would prevent the technology from functioning properly. We also project as one possible compliance pathway that manufacturers could apply other more advanced technologies such as hybrids and waste engine heat recovery systems, although at lower application rates.

Under Alternative 3, the preferred alternative, the agencies propose to provide ten years of lead time for manufacturers to meet these 2027 standards, which the agencies believe is adequate to implement the technologies industry could use to meet the proposed standards. For some of the more advanced technologies production prototype parts are not yet available, though they are in the research stage with some demonstrations in actual vehicles.[49] Additionally, even for the more developed technologies, phasing in more stringent standards over a longer timeframe may help manufacturers to ensure better reliability of the technology and to develop packages to work in a wide range of applications. Moving more quickly, however, as in Alternative 4, would lead to earlier and greater cumulative fuel savings and greenhouse gas reductions.

As discussed later, the agencies are also proposing new standards in MYs 2018 (trailers only), 2021, and 2024 to ensure manufacturers make steady progress toward the 2027 standards, thereby achieving steady and feasible reductions in GHG emissions and fuel consumption in the years leading up to the MY 2027 standards. Moving more quickly, however, as in Alternative 4, would lead to earlier and greater cumulative fuel and greenhouse gas savings.

Providing additional lead time can often enable manufacturers to resolve technological challenges or to find lower cost means of meeting new regulatory standards, effectively making them more feasible in either case. See generally *NRDC* v. *EPA,* 655 F. 2d 318, 329 (D.C. Cir. 1981). On the other hand, manufacturers and/or operators may incur additional costs if regulations require them to make changes to their products with less lead time than manufacturers would normally have when bringing a new technology to the market or expanding the application of existing technologies. After developing a new technology, manufacturers typically conduct extensive field tests to ensure its durability and reliability in actual use. Standards that accelerate technology deployment can lead to manufacturers incurring additional costs to accelerate this development work, or can lead to manufacturers beginning production before such testing can be completed. Some industry stakeholders have informed EPA that when manufacturers introduced new emission control technologies (primarily diesel particulate filters) in response to the 2007 heavy-duty engine standards

[48] In this context, the term ''technology-forcing'' is used to distinguish standards that will effectively require manufacturers to develop new technologies (or to significantly improve technologies) from standards that can be met using off-the-shelf technology alone. Technology-forcing standards do not require manufacturers to use any specific technologies.

[49] ''Prototype'' as it is used here refers to technologies that have a potentially production-feasible design that is expected to meet all performance, functional, reliability, safety, manufacturing, cost and other requirements and objectives that is being tested in laboratories and on highways under a full range of operating conditions, but is not yet available in production vehicles already for sale in the market.

they did not perform sufficient product development validation, which led to additional costs for operators when the technologies required repairs or other resulted in other operational issues in use. Thus, the issues of costs, lead time, and reliability are intertwined for the agencies' determination of whether standards are reasonable.

Another important consideration is the possibility of disrupting the market, such as might happen if we were to adopt standards that manufacturers respond to by applying a new technology too suddenly. Several of the heavy-duty vehicle manufacturers, fleets, and commercial truck dealerships informed the agencies that for fleet purchases that are planned more than a year in advance, *expectations* of reduced reliability, increased operating costs, reduced residual value, or of large increases in purchase prices can lead the fleets to pull-ahead by several months planned future vehicle purchases by pre-buying vehicles without the newer technology. In the context of the Class 8 tractor market, where a relatively small number of large fleets typically purchase very large volumes of tractors, such actions by a small number of firms can result in large swings in sales volumes. Such market impacts would be followed by some period of reduced purchases that can lead to temporary layoffs at the factories producing the engines and vehicles, as well as at supplier factories, and disruptions at dealerships. Such market impacts also can reduce the overall environmental and fuel consumption benefits of the standards by delaying the rate at which the fleet turns over. See *International Harvester* v. *EPA,* 478 F. 2d 615, 634 (D.C. Cir. 1973). A number of industry stakeholders have informed EPA that the 2007 EPA heavy-duty engine criteria pollutant standard resulted in this pull-ahead phenomenon for the Class 8 tractor market. The agencies understand the potential impact that a pull-ahead can have on American manufacturing and labor, dealerships, truck purchasers, and on the program's environmental and fuel savings goals, and have taken steps in the design of the proposed program to avoid such disruption. These steps include the following:

- Providing considerable lead time, including two to three additional years for the preferred alternative compared to Alternative 4
- The standards will result in significantly lower operating costs for vehicle owners (unlike the 2007 standard, which increased operating costs)
- Phasing in the standards
- Structuring the program so the industry will have a significant range of technology choices to be considered for compliance, rather than the one or two new technologies the OEMs pursued in 2007
- Allowing manufacturers to use emissions averaging, banking and trading to phase in the technology even further

We request comment on the sufficiency of the proposed Phase 2 structure, lead time, and stringency to avoid market disruptions. We note an important difference, however, between standards for criteria pollutants, with generally no attendant fuel savings, and the fuel consumption/GHG emission standards proposed today, which provide immediate and direct financial benefits to vehicle purchasers, who will begin saving money on fuel costs as soon as they begin operating the vehicles. It would seem logical, therefore, that vehicle purchasers (and manufacturers) would weigh those significant fuel savings against the potential for increased costs that could result from applying fuel-saving technologies sooner than they might otherwise choose in the absence of the standards.

As discussed in the Phase 1 final rule, NHTSA has certain statutory considerations to take into account when determining feasibility of the preferred alternative.[50] The Energy Independence and Security Act (EISA) states that NHTSA (in consultation with EPA and the Secretary of Energy) shall develop a commercial medium- and heavy-duty fuel efficiency program designed ''to achieve the maximum feasible improvement.''[51] Although there is no definition of maximum feasible standards in EISA, NHTSA is directed to consider three factors when determining what the maximum feasible standards are. Those factors are, appropriateness, cost-effectiveness, and technological feasibility,[52] which modify ''feasible'' beyond its plain meaning.

NHTSA has the broad discretion to weigh and balance the aforementioned factors in order to accomplish EISA's mandate of determining maximum feasible standards. The fact that the factors may often be at odds gives NHTSA significant discretion to decide what weight to give each of the competing factors, policies and concerns and then determine how to balance them—as long as NHTSA's balancing does not undermine the fundamental purpose of the EISA: Energy conservation, and as long as that balancing reasonably accommodates ''conflicting policies that were committed to the agency's care by the statute.''[53]

EPA also has significant discretion in assessing, weighing, and balancing the relevant statutory criteria. Section 202(a)(2) of the Clean Air Act requires that the standards ''take effect after such period as the Administrator finds necessary to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period.'' This language affords EPA considerable discretion in how to weight the critical statutory factors of emission reductions, cost, and lead time (76 FR 57129–57130). Section 202(a) also allows (although it does not compel) EPA to adopt technology-forcing standards. Id. at 57130.

Giving due consideration to the agencies' respective statutory criteria discussed above, the agencies are proposing these technology-forcing standards for MY 2027. The agencies nevertheless recognize that there is some uncertainty in projecting costs and effectiveness, especially for those technologies not yet widely available, but believe that the thresholds proposed for consideration account for realistic projections of technological development discussed throughout this notice and in the draft RIA. The agencies are requesting comment on the alternatives described in Section X below. These alternatives range from Alternative 1 (which is a no-action alternative that serves as the baseline for our cost and benefit analyses) to Alternative 5 (which includes the most stringent of the alternative standards analyzed by the agencies). The assessment of these different alternatives considers the importance of allowing manufacturers sufficient flexibility and discretion while achieving meaningful fuel consumption and GHG emissions reductions across vehicle types. The agencies look forward to receiving comments on questions of feasibility and long-term projections of costs and effectiveness.

As discussed throughout this document, the agencies believe Alternative 4 has potential to be the maximum feasible alternative, however, based on the evidence currently before us, the agencies have outstanding questions regarding relative risks and

[50] 75 FR 57198.

[51] 49 U.S.C. 32902(k).

[52] *Id.*

[53] Center for Biological Diversity v. National Highway Traffic Safety Admin., *538 F.3d 1172, 1195 (9th Cir. 2008).*

benefits of that option in the timeframe envisioned. We are seeking comment on these relative risks and benefits. Alternative 3 is generally designed to achieve the vehicle levels of fuel consumption and GHG reduction that Alternative 4 would achieve, but with two to three years of additional lead-time—*i.e.,* the Alternative 3 standards would end up in the same place as the Alternative 4 standards, but two to three years later, meaning that manufacturers could, in theory, apply new technology at a more gradual pace and with greater flexibility as discussed above. However, Alternative 4 would lead to earlier and greater cumulative fuel savings and greenhouse gas reductions.

In the sections that follow, the agencies have closely examined the potential feasibility of Alternative 4 for each subcategory. The agencies may consider establishing final fuel efficiency and GHG standards in whole or in part in the Alternative 4 timeframe if we deem them to be maximum feasible and reasonable for NHTSA and EPA, respectively. The agencies seek comment on the feasibility of Alternative 4, whether for some or for all segments, including empirical data on its appropriateness, cost-effectiveness, and technological feasibility. The agencies also note the possibility of adoption in MY 2024 of a standard reflecting deployment of some, rather than all, of the technologies on which Alternative 4 is predicated. It is also possible that the agencies could adopt some or all of the proposal (Alternative 3) earlier than MY 2027, but later than MY 2024, based especially on lead time considerations. Any such choices would involve a considered weighing of the issues of feasibility of projected technology penetration rates, associated costs, and necessary lead time, and would consider the information on available technologies, their level of performance and costs set out in the administrative record to this proposal.

Sections II through VI of this notice explain the consideration that the agencies took into account in considering options and proposing a preferred alternative based on balancing of the statutory factors under 42 U.S.C. 7521(a)(1) and (2), and under 49 U.S.C. 32902(k).

(1) Carryover From Phase 1 Program and Proposed Compliance Changes

Phase 2 will carry over many of the compliance approaches developed for Phase 1, with certain changes as described below. Readers are referred to the proposed regulatory text for much more detail. Note that some of these provisions are being carried over with revisions or additions (such as those needed to address trailers).

(a) Certification

EPA and NHTSA are proposing to apply the same general certification procedures for Phase 2 as are currently being used for certifying to the Phase 1 standards. The agencies, however, are proposing changes to the simulation tool used for the vocational vehicle, tractor and trailer standards that would allow the simulation tool to more specifically reflect improvements to transmissions and drivetrains.[54] Rather than the model using default values for transmissions and drivetrains, manufacturers would enter measured or tested values as inputs reflecting performance of their actual transmission and drivetrain technologies.

The agencies apply essentially the same process for certifying tractors and vocational vehicles, and propose largely to apply it to trailers as well. The Phase 1 certification process for engines used in tractors and vocational vehicles was based on EPA's process for showing compliance with the heavy-duty engine criteria pollutant standards, and the agencies propose to continue it for Phase 2. Finally, we also propose to continue certifying HD pickups and vans using the Phase 1 vehicle certification process, which is very similar to the light-duty vehicle certification process.

EPA and NHTSA are also proposing to clarify provisions related to confirming a manufacturer's test data during certification (*i.e.,* confirmatory testing) and verifying a manufacturer's vehicles are being produced to perform as described in the application for certification (*i.e.,* selective enforcement audits or SEAs). The EPA confirmatory testing provisions for engines and vehicles are in 40 CFR 1036.235 and 1037.235. The SEA provisions are in 40 CFR 1036.301 and 1037.301. The NHTSA provisions are in 49 CFR 535.9(a). Note that these clarifications would also apply for Phase 1 engines and vehicles. The agencies welcome suggestions for alternative approaches that would offer the same degree of compliance assurance for GHGs and fuel consumption as these programs offer with respect to EPA's criteria pollutants.

[54] As described in Section IV, although the proposed trailer standards were developed using the simulation tool, the agencies are proposing a compliance structure that does not require trailer manufacturers to actually use the compliance tool.

(b) Averaging, Banking and Trading (ABT)

The Phase 1 ABT provisions were patterned on established EPA ABT programs that have proven to work well. In Phase 1, the agencies determined this flexibility would provide an opportunity for manufacturers to make necessary technological improvements and reduce the overall cost of the program without compromising overall environmental and fuel economy objectives. We propose to generally continue this Phase 1 approach with few revisions for vehicles regulated in Phase 1. As described in Section IV, we are proposing a more limited averaging program for trailers. The agencies see the ABT program as playing an important role in making the proposed technology-advancing standards feasible, by helping to address many issues of technological challenges in the context of lead time and costs. It provides manufacturers flexibilities that assist the efficient development and implementation of new technologies and therefore enable new technologies to be implemented at a more aggressive pace than without ABT.

ABT programs are more than just add-on provisions included to help reduce costs, and can be, as in EPA's Title II programs generally, an integral part of the standard setting itself. A well-designed ABT program can also provide important environmental and energy security benefits by increasing the speed at which new technologies can be implemented (which means that more benefits accrue over time than with later-commencing standards) and at the same time increase flexibility for, and reduce costs to, the regulated industry and ultimately consumers. Without ABT provisions (and other related flexibilities), standards would typically have to be numerically less stringent since the numerical standard would have to be adjusted to accommodate issues of feasibility and available lead time. See 75 FR 25412–25413. By offering ABT credits and additional flexibilities the agencies can offer progressively more stringent standards that help meet our fuel consumption reduction and GHG emission goals at a faster and more cost-effective pace.[55]

(i) Carryover of Phase 1 Credits and Credit Life

The agencies propose to continue the five-year credit life provisions from Phase 1, and are not proposing any

[55] See NRDC v. Thomas, 805 F. 2d 410, 425 (D.C. Cir. 1986) (upholding averaging as a reasonable and permissible means of implementing a statutory provision requiring technology-forcing standards).

additional restriction on the use of banked Phase 1 credits in Phase 2. In other words, Phase 1 credits in MY2019 could be used in Phase 1 or in Phase 2 in MYs 2021–2024. Although, as we have already noted, the numerical values of proposed Phase 2 standards are not directly comparable in an absolute sense to the existing Phase 1 standards (in other words, a given vehicle would have a different g/ton-mile emission rate when evaluated using Phase 1 GEM than it would when evaluated using Phase 2 GEM), we believe that the Phase 1 and Phase 2 credits are largely equivalent. Because the standards and emission levels are included in a relative sense (as a difference), it is not necessary for the Phase 1 and Phase 2 standards to be directly equivalent in an absolute sense in order for the credits to be equivalent.

This is best understood by examining the way in which credits are calculated. For example, the credit equations in 40 CFR 1037.705 and 49 CFR 535.7 calculate credits as the product of the difference between the standard and the vehicle's emission level (g/ton-mile or gallon/1,000 ton-mile), the regulatory payload (tons), production volume, and regulatory useful life (miles). Phase 2 would not change payloads, production volumes, or useful lives for tractors, medium and heavy heavy-duty engines, or medium and heavy heavy-duty vocational vehicles. However, EPA is proposing to change the regulatory useful lives of HD pickups and vans, light heavy-duty vocational vehicles, spark-ignited engines, and light heavy-duty compression-ignition engines. Because useful life is a factor in determining the value of a credit, the agencies are proposing interim adjustment factors to ensure banked credits maintain their value in the transition from Phase 1 to Phase 2.

For Phase 1, EPA aligned the useful life for GHG emissions with the useful life already in place for criteria pollutants. After the Phase 1 rules were finalized, EPA updated the useful life for criteria pollutants as part of the Tier 3 rulemaking.[56] The new useful life implemented for Tier 3 is 150,000 miles or 15 years, whichever occurs first. This is the same useful life proposed in Phase 2 for HD pickups and vans, light heavy-duty vocational vehicles, spark-ignited engines, and light heavy-duty compression-ignition engines.[57] The numerical value of the adjustment factor for each of these regulatory categories depends on the Phase 1 useful life. These are described in detail below in this preamble in Sections II, V, and VI. Without these adjustment factors the proposed changes in useful life would effectively result in a discount of banked credits that are carried forward from Phase 1 to Phase 2, which is not the intent of the changes in the useful life. With the relatively flat deterioration generally associated with CO_2, EPA does not believe the proposed changes in useful life would significantly affect the feasibility of the proposed Phase 2 standards. EPA requests comments on the proposed changes to useful life. We note that the primary purpose of allowing manufacturers to bank credits is to provide flexibility in managing transitions to new standards. The five-year credit life is substantial, and would allow credits generated in either Phase 1 or early in Phase 2 to be used for the intended purpose. The agencies believe longer credit life is not necessary to accomplish this transition. Restrictions on credit life serve to reduce the likelihood that any manufacturer would be able to use banked credits to disrupt the heavy-duty vehicle market in any given year by effectively limiting the amount of credits that can be held. Without this limit, one manufacturer that saved enough credits over many years could achieve a significant cost advantage by using all the credits in a single year. The agencies believe, subject to consideration of public comment, that allowing a five year credit life for all credits, and as a consequence allowing use of Phase 1 credits in Phase 2, creates appropriate flexibility and appropriately facilitates a smooth transition to each new level of standards.

Although we are not proposing any additional restrictions on the use of Phase 1 credits, we are requesting comment on this issue. Early indications suggest that positive market reception to the Phase 1 technologies could lead to manufacturers accumulating credit surpluses that could be quite large at the beginning of the proposed Phase 2 program. This appears especially likely for tractors. The agencies are specifically requesting comment on the likelihood of this happening, and whether any regulatory changes would be appropriate in response. For example, should the agencies limit the amount of credits that could be carried over from Phase1 or limit them to the first year or two of the Phase 2 program? Also, if we determine that large surpluses are likely, how should that factor into our decision on the feasibility of more stringent standards in MY 2021?

(ii) Averaging Sets

EPA has historically restricted averaging to some extent for its HD emission standards to avoid creating unfair competitive advantages or environmental risks due to credits being inconsistent. Under Phase 1, averaging, banking and trading can only occur within and between specified ''averaging sets'' (with the exception of credits generated through use of specified advanced technologies). We propose to continue this regime in Phase 2, to retain the existing vehicle and engine averaging sets, and create new trailer averaging sets. We also propose to continue the averaging set restrictions from Phase 1 in Phase 2. These averaging sets for vehicles are:

- Complete pickups and vans
- Other light heavy-duty vehicles (Classes 2b–5)
- Medium heavy-duty vehicles (Class 6–7)
- Heavy heavy-duty vehicles (Class 8)
- Long dry van trailers
- Short dry van trailers
- Long refrigerated trailers
- Short refrigerated trailers

We also propose not to allow trading between engines and chassis, even within the same vehicle class. Such trading would essentially result in double counting of emission credits, because the same engine technology would likely generate credits relative to both standards. We similarly would limit trading among engine categories to trades within the designated averaging sets:

- Spark-ignition engines
- Compression-ignition light heavy-duty engines
- Compression-ignition medium heavy-duty engines
- Compression-ignition heavy heavy-duty engines

The agencies continue to believe that restricting trading to within the same eight classes would provide adequate opportunities for manufacturers to make necessary technological improvements and to reduce the overall cost of the program without compromising overall environmental and fuel efficiency objectives, and is therefore appropriate and reasonable under EPA's authority and maximum feasible under NHTSA's authority, respectively. We do not expect emissions from engines and vehicles—when restricted by weight class—to be dissimilar. We therefore expect that the lifetime vehicle performance and emissions levels will be very similar across these defined

[56] 79 FR 23492, April 28, 2014 and 40 CFR 86.1805–17.

[57] NHTSA's useful life is based on mileage and years of duration.

categories, and the estimated credit calculations will fairly ensure the expected fuel consumption and GHG emission reductions.

We continue to believe, subject to consideration of public comment, that the Phase 1 averaging sets create the most flexibility that is appropriate without creating an unfair advantage for manufacturers with erratically integrated portfolios, including engines and vehicles. See 76 FR 57240. The agencies committed in Phase 1 to seek public comment after credit trading begins with manufacturers certifying in 2014 on whether broader credit trading is more appropriate in developing the next phase of HD regulations (76 FR 57128, September 15, 2011). The 2014 model year end of year reports will become available to the agencies in mid-2015. Therefore, the agencies will provide information at that point. We welcome comment on averaging set restrictions. The agencies propose to continue this carry forward provision for phase 2 for the same reasons.

(iii) Credit Deficits

The Phase 1 regulations allow manufacturers to carry-forward deficits for up to three years without penalty. This is an important flexibility because the program is designed to address the diversity of the heavy-duty industry by allowing manufacturers to sell a mix of engines or vehicles that have very different emission levels and fuel efficiencies. Under this construct, manufacturers can offset sales of engines or vehicles not meeting the standards by selling others (within the same averaging set) that are much better than required. However, in any given year it is possible that the actual sales mix will not balance out and the manufacturer may be short of credits for that model year. The three year provision allows for this possibility and creates additional compliance flexibility to accommodate it.

(iv) Advanced Technology Credits

At this time, the agencies believe it is no longer appropriate to provide extra credit for the technologies identified as advanced technologies for Phase 1, although we are requesting comment on this issue. The Phase 1 advanced technology credits were adopted to promote the implementation of advanced technologies, such as hybrid powertrains, Rankine cycle engines, all-electric vehicles, and fuel cell vehicles (see 40 CFR 1037.150(i)). As the agencies stated in the Phase 1 final rule, the Phase 1 standards were not premised on the use of advanced technologies but we expected these advanced technologies to be an important part of the Phase 2 rulemaking (76 FR 57133, September 15, 2011). The proposed Phase 2 heavy-duty engine and vehicles standards are premised on the use of some advanced technologies, making them equivalent to other fuel-saving technologies in this context. We believe the Phase 2 standards themselves would provide sufficient incentive to develop them.

We request comment on this issue, especially with respect to electric vehicle, plug-in hybrid, and fuel cell technologies. Although the proposed standards are premised on some use of Rankine cycle engines and hybrid powertrains, none of the proposed standards are based on projected utilization of the use of the other advanced technologies. (Note that the most stringent alternative is based on some use of these technologies). Commenters are encouraged to consider the recently adopted light-duty program, which includes temporary incentives for these technologies.

(c) Innovative Technology and Off-Cycle Credits

The agencies propose to largely continue the Phase 1 innovative technology program but to redesignate it as an off-cycle program for Phase 2. In other words, beginning in MY 2021 technologies that are not fully accounted for in the GEM simulation tool, or by compliance dynamometer testing would be considered ''off-cycle'', including those technologies that may no longer be considered innovative technologies. However, we are not proposing to apply this flexibility to trailers (which were not part of Phase 1) in order to simplify the program for trailer manufacturers.

The agencies propose to maintain that, in order for a manufacturer to receive credits for Phase 2, the off-cycle technology would still need to meet the requirement that it was not in common use prior to MY 2010. Although, we have not identified specific off-cycle technologies at this time that should be excluded, we believe it may be prudent to continue this requirement to avoid the potential for manufacturers to receive windfall credits for technologies that they were already using before MY 2010. Nevertheless, the agencies seek comment on whether off-cycle technologies in the Phase 2 program should be limited in this way. In particular, the agencies are concerned that because the proposed Phase 2 program would be implemented MY 2021 and may extend beyond 2027, the agencies and manufacturers may have difficulty in the future determining whether an off-cycle technology was in common use prior to MY 2010. Moreover, because we have not identified a single off-cycle technology that should be excluded by this provision at this time, we are concerned that this approach may create an unnecessary hindrance to the off-cycle program.

Manufacturers would be able to carry over an innovative technology credits from Phase 1 into Phase 2, subject to the same restrictions as other credits. Manufacturers would also be able to carry over the improvement factor (not the credit value) of a technology, if certain criteria were met. The agencies would require documentation for all off-cycle requests similar to those required by EPA for its light-duty GHG program.

Additionally, NHTSA would not grant any off-cycle credits for crash avoidance technologies. NHTSA would also require manufacturers to consider the safety of off-cycle technologies and would request a safety assessment from the manufacturer for all off-cycle technologies.

The agencies seek comment on these proposed changes, as well as the possibility of adopting aspects of the light-duty off-cycle program.

(d) Alternative Fuels

The agencies are proposing to largely continue the Phase 1 approach for engines and vehicles fueled by fuels other than gasoline and diesel.[58] Phase 1 engine emission standards applied uniquely for gasoline-fueled and diesel-fueled engines. The regulations in 40 CFR part 86 implement these distinctions for alternative fuels by dividing engines into Otto-cycle and Diesel-cycle technologies based on the combustion cycle of the engine. The agencies are, however, proposing a small change that is described in Section II. Under the proposed change, we would require manufacturers to divide their natural gas engines into primary intended service classes, like the current requirement for compression-ignition engines. Any alternative fuel-engine qualifying as a medium heavy-duty engine or a heavy heavy-duty engine would be subject to all the emission standards and other requirements that apply to compression-ignition engines. Note that this small change in approach would also apply with respect to EPA's criteria pollutant program.

We are also proposing that the Phase 2 standards apply exclusively at the

[58] See Section I. F. (1) (a) for a summary of certain specific changes we are proposing or considering for natural gas-fueled engines and vehicles.

vehicle tailpipe. That is, compliance is based on vehicle fuel consumption and GHG emission reductions, and does not reflect any so-called lifecycle emission properties. The agencies have explained why it is reasonable that the heavy duty standards be fuel neutral in this manner. See 76 FR 57123; see also 77 FR 51705 (August 24, 2012) and 77 FR 51500 (August 27, 2012). In particular, EPA notes that there is a separate, statutorily-mandated program under the Clean Air Act which encourages use of renewable fuels in transportation fuels, including renewable fuel used in heavy-duty diesel engines. This program considers lifecycle greenhouse gas emissions compared to petroleum fuel. NHTSA notes that the fuel efficiency standards are necessarily tailpipe-based, and that a lifecycle approach would likely render it impossible to harmonize the fuel efficiency and GHG emission standards, to the great detriment of our goal of achieving a coordinated program. 77 FR 51500–51501; see also 77 FR 51705 (similar finding by EPA); see also section I.F. (1) (a) below.

One consequence of the tailpipe-based approach is that the agencies are proposing to treat vehicles powered by electricity the same as in Phase 1. In Phase 1, EPA treated all electric vehicles as having zero emissions of CO_2, CH_4, and N_2O (see 40 CFR 1037.150(f)). Similarly, NHTSA adopted regulations in Phase 1 that set the fuel consumption standards based on the fuel consumed by the vehicle. The agencies also did not require emission testing for electric vehicles in Phase 1. The agencies considered the potential unintended consequence of not accounting for upstream emissions from the charging of heavy-duty electric vehicles. In our reassessment for Phase 2, we have not found any all-electric heavy-duty vehicles that have certified by 2014. As we look to the future, we project very limited adoption of all-electric vehicles into the market. Therefore, we believe that this provision is still appropriate. Unlike the 2017–2025 light-duty rule, which included a cap whereby upstream emissions would be counted after a certain volume of sales (see 77 FR 62816–62822), we believe there is no need to propose a cap for heavy-duty vehicles because of the small likelihood of significant production of EV technologies in the Phase 2 timeframe. We welcome comments on this approach.[59] Note that we also request comment on upstream emissions for natural gas in Section XI.

(e) Phase 1 Interim Provisions

EPA adopted several flexibilities for the Phase 1 program (40 CFR 1036.150 and 1037.150) as interim provisions. Because the existing regulations do not have an end date for Phase 1, most of these provisions did not have an explicit end date. NHTSA adopted similar provisions. With few exceptions, the agencies are proposing not to apply these provisions to Phase 2. These will generally remain in effect for the Phase 1 program. In particular, the agencies note that we do not propose to continue the blanket exemption for small manufacturers. Instead, the agencies propose to adopt narrower and more targeted relief.

(f) In-Use Standards

Section 202(a)(1) of the CAA specifies that EPA is to adopt emissions standards that are applicable for the useful life of the vehicle and for the engine. EPA finalized in-use standards for the Phase 1 program whereas NHTSA adopted an approach which does not include these standards. For the Phase 2 program, EPA will carry-over its in-use provisions and NHTSA proposes to adopt EPA's useful life requirements for its vehicle and engine fuel consumption standards to ensure manufacturers consider in the design process the need for fuel efficiency standards to apply for the same duration and mileage as EPA standards. If EPA determines a manufacturer fails to meet its in-use standards, civil penalties may be assessed. NHTSA seeks comment on the appropriateness of seeking civil penalties for failure to comply with its fuel efficiency standards in these instances. NHTSA would limit such penalties to situations in which it determined that the vehicle or engine manufacturer failed to comply with the standards.

(2) Proposed Phase 2 Standards

This section briefly summarizes the proposed Phase 2 standards for each category and identifies the technologies that the agencies project would be needed to meet the standards. Given the large number of different regulatory categories and model years for which separate standards are being proposed, the actual numerical standards are not listed. Readers are referred to Sections II through IV for the tables of proposed standards.

(a) Summary of the Proposed Engine Standards

The agencies are proposing to continue the basic Phase 1 structure for the Phase 2 engine standards. There would be separate standards and test cycles for tractor engines, vocational diesel engines, and vocational gasoline engines. However, as described in Section II, we are proposing a revised test cycle for tractor engines to better reflect actual in-use operation.

For diesel engines, the agencies are proposing standards for MY 2027 requiring reduction in CO_2 emissions and fuel consumption of 4.2 percent better than the 2017 baseline.[60] We are also proposing standards for MY 2021 and MY 2024, requiring reductions in CO_2 emissions and fuel consumption of 1.5 to 3.7 percent better than the 2017 baseline. The agencies project that these reductions would be feasible based on technological changes that would improve combustion and reduce energy losses. For most of these improvements, the agencies project manufacturers will begin applying them to about 50 percent of their heavy-duty engines by 2021, and ultimately apply them to about 90 percent of their heavy-duty engines by 2024. However, for some of these improvements we project more limited application rates. In particular, we project a more limited use of waste exhaust heat recovery systems in 2027, projecting that about 10 percent of tractor engines will have turbo-compounding systems, and an additional 15 percent of tractor engines would employ Rankine-cycle waste heat recovery. We do not project that turbo-compounding or Rankine-cycle waste heat recovery technology will be utilized in vocational engines. Although we see great potential for waste heat recovery systems to achieve significant fuel savings and CO_2 emission reductions, we are not projecting that the technology could be available for more wide-spread use in this time frame.

For gasoline vocational engines, we are not proposing new more stringent *engine* standards. Gasoline engines used in vocational vehicles are generally the same engines as are used in the complete HD pickups and vans in the Class 2b and 3 weight categories. Given the relatively small sales volumes for gasoline-fueled vocational vehicles, manufacturers typically cannot afford to invest significantly in developing separate technology for these vocational vehicle engines. Thus, we project that vocational gasoline engines would

[59] See also Section I. C. (1) (b)(iv) above (soliciting comment on need for advanced technology incentive credits for heavy duty EVs).

[60] Phase 1 standards for diesel engines will be fully phased-in by MY 2017.

include the same technology as would be used to meet the pickup and van chassis standards, and this would result in some real world reductions in CO_2 emissions and fuel consumption. Although it is difficult at this time to project how much improvement would be observed during certification testing, it seems likely that these improvements would reduce measured CO_2 emissions and fuel consumption by about one percent. Therefore, we are requesting comment on finalizing a Phase 2 standard of 621 g/hp-hr for gasoline engines (*i.e.,* one percent more stringent than the 2016 Phase 1 standard of 627 g/hp-hr) in MY 2027. We note that the proposed MY 2027 vehicle standards for gasoline-fueled vocational vehicles are predicated in part on the use of advanced friction reduction technology with effectiveness over the GEM cycles of about one percent. We also request comment on whether not proposing more stringent standards for gasoline engines would create an incentive for purchasers who would have otherwise chosen a diesel vehicle to instead choose a gasoline vehicle.

TABLE I–2—SUMMARY OF PHASE 1 AND PROPOSED PHASE 2 REQUIREMENTS FOR ENGINES IN COMBINATION TRACTORS AND VOCATIONAL VEHICLES

	Phase 1 program	Alternative 3–2027 (proposed standard)	Alternative 4–2024 (also under consideration)
Covered in this category	Engines installed in tractors and vocational chassis.		
Share of HDV fuel consumption and GHG emissions.	Combination tractors and vocational vehicles account for approximately 85 percent of fuel use and GHG emissions in the medium and heavy duty truck sector.		
Per vehicle fuel consumption and CO_2 improvement.	5%–9% improvement over MY 2010 baseline, depending vehicle application. Improvements are in addition to improvements from tractor and vocational vehicle standards.	4% improvement over MY 2017 for diesel engines. Note that improvements are captured in complete vehicle tractor and vocational vehicle standards, so that engine improvements and the vehicle improvement shown below are not additive.	
Form of the standard	EPA: CO_2 grams/horsepower-hour and NHTSA: Gallons of fuel/horsepower-hour.		
Example technology options available to help manufacturers meet standards.	Combustion, air handling, friction and emissions after-treatment technology improvements.	Further technology improvements and increased use of all Phase 1 technologies, plus waste heat recovery systems for tractor engines (e.g., turbo-compound and Rankine-cycle).	
Flexibilities	ABT program which allows emissions and fuel consumption credits to be averaged, banked, or traded (five year credit life). Manufacturers allowed to carry-forward credit deficits for up to three model years. Interim incentives for advanced technologies, recognition of innovative (off-cycle) technologies not accounted for by the HD Phase 1 test procedures, and credits for certifying early.	Same as Phase 1, except no advanced technology incentives. Adjustment factor of 1.36 proposed for credits carried forward from Phase 1 to Phase 2 for SI and LHD CI engines due to proposed change in useful life.	

(b) Summary of the Proposed Tractor Standards

As explained in Section III, the agencies are proposing to largely continue the Phase 1 tractor program but to propose new standards. The tractor standards proposed for MY 2027 would achieve up to 24 percent lower CO_2 emissions and fuel consumption than a 2017 model year Phase 1 tractor. The agencies project that the proposed 2027 tractor standards could be met through improvements in the:

- Engine[61] (including some use of waste heat recovery systems)
- Transmission
- Driveline
- Aerodynamic design
- Tire rolling resistance
- Idle performance
- Other accessories of the tractor.

The agencies' evaluation shows that some of these technologies are available today, but have very low adoption rates on current vehicles, while others will require some lead time for development. The agencies are proposing to enhance the GEM vehicle simulation tool to recognize these technologies, as described in Section II.C.

We have also determined that there is sufficient lead time to introduce many of these tractor and engine technologies into the fleet at a reasonable cost starting in the 2021 model year. The proposed 2021 model year standards for combination tractors and engines would achieve up to 13 percent lower CO_2 emissions and fuel consumption than a 2017 model year Phase 1 tractor, and the 2024 model year standards would achieve up to 20 percent lower CO_2 emissions and fuel consumption.

[61] Although the agencies are proposing separate engine standards and separate engine certification, engine improvements would also be reflected in the vehicle certification process. Thus, it is appropriate to also consider engine improvements in the context of the vehicle standards.

TABLE I–3—SUMMARY OF PHASE 1 AND PROPOSED PHASE 2 REQUIREMENTS FOR CLASS 7 AND CLASS 8 COMBINATION TRACTORS

	Phase 1 program	Alternative 3—2027 (proposed standard)	Alternative 4—2024 (also under consideration)
Covered in this category	Tractors that are designed to pull trailers and move freight.		
Share of HDV fuel consumption and GHG emissions.	Combination tractors and their engines account for approximately two thirds of fuel use and GHG emissions in the medium and heavy duty truck sector.		
Per vehicle fuel consumption and CO_2 improvement.	10%–23% improvement over MY 2010 baseline, depending on tractor category. Improvements are in addition to improvements from engine standards.	18%–24% improvement over MY 2017 standards.	
Form of the standard	EPA: CO_2 grams/ton payload mile and NHTSA: Gallons of fuel/1,000 ton payload mile.		
Example technology options available to help manufacturers meet standards.	Aerodynamic drag improvements; low rolling resistance tires; high strength steel and aluminum weight reduction; extended idle reduction; and speed limiters.	Further technology improvements and increased use of all Phase 1 technologies, plus engine improvements, improved and automated transmissions and axles, powertrain optimization, tire inflation systems, and predictive cruise control (depending on tractor type).	
Flexibilities	ABT program which allows emissions and fuel consumption credits to be averaged, banked, or traded (five year credit life). Manufacturers allowed to carry-forward credit deficits for up to three model years. Interim incentives for advanced technologies, recognition of innovative (off-cycle) technologies not accounted for by the HD Phase 1 test procedures, and credits for certifying early.	Same as Phase 1, except no extra credits for advanced technologies or early certification.	

(c) Summary of the Proposed Trailer Standards

This proposed rule is a set of GHG emission and fuel consumption standards for manufacturers of new trailers that are used in combination with tractors that would significantly reduce CO_2 and fuel consumption from combination tractor-trailers nationwide over a period of several years. As described in Section IV, there are numerous aerodynamic and tire technologies available to manufacturers to accomplish these proposed standards. For the most part, these technologies have already been introduced into the market to some extent through EPA's voluntary SmartWay program. However, adoption is still somewhat limited.

The agencies are proposing incremental levels of Phase 2 standards that would apply beginning in MY 2018 and be fully phased-in by 2027. These standards are predicated on use of aerodynamic and tire improvements, with trailer OEMs making incrementally greater improvements in MYs 2021 and 2024 as standard stringency increases in each of those model years. EPA's GHG emission standards would be mandatory beginning in MY 2018, while NHTSA's fuel consumption standards would be voluntary beginning in MY 2018, and be mandatory beginning in MY 2021.

As described in Section XV.D and Chapter 12 of the draft RIA, the agencies are proposing special provisions to minimize the impacts on small trailer manufacturers. These provisions have been informed by and are largely consistent with recommendations coming from the SBAR Panel that EPA conducted pursuant to Section 609(b) of the Regulatory Flexibility Act (RFA). Broadly, these provisions provide additional lead time for small manufacturers, as well as simplified testing and compliance requirements. The agencies are also requesting comment on whether there is a need for additional provisions to address small business issues.

TABLE I–4—SUMMARY OF PROPOSED PHASE 2 REQUIREMENTS FOR TRAILERS

	Phase 1 program	Alternative 3—2027 (proposed standard)	Alternative 4—2024 (also under consideration)
Covered in this category	Trailers hauled by low, mid, and high roof day and sleeper cab tractors, except those qualified as logging, mining, stationary or heavy-haul.		
Share of HDV fuel consumption and GHG emissions.	Trailers are modeled together with combination tractors and their engines. Together, they account for approximately two thirds of fuel use and GHG emissions in the medium and heavy duty truck sector.		
Per vehicle fuel consumption and CO_2 improvement.	N/A	Between 3% and 8% improvement over MY 2017 baseline, depending on the trailer type.	

TABLE I–4—SUMMARY OF PROPOSED PHASE 2 REQUIREMENTS FOR TRAILERS—Continued

	Phase 1 program	Alternative 3—2027 (proposed standard)	Alternative 4—2024 (also under consideration)
Form of the standard	N/A	EPA: CO_2 grams/ton payload mile and NHTSA: Gallons/1,000 ton payload mile.	
Example technology options available to help manufacturers meet standards.	N/A	Low rolling resistance tires, automatic tire inflation systems, weight reduction for most trailers, aerodynamic improvements such as side and rear fairings, gap closing devices, and undercarriage treatment for box-type trailers (*e.g.,* dry and refrigerated vans).	
Flexibilities	N/A	One year delay in implementation for small businesses, trailer manufacturers may use pre-approved devices to avoid testing, averaging program for manufacturers of dry and refrigerated box trailers.	

(d) Summary of the Proposed Vocational Vehicle Standards

As explained in Section V, the agencies are proposing to revise the Phase 1 vocational vehicle program and to propose new standards. These proposed standards also reflect further sub-categorization from Phase 1, with separate proposed standards based on mode of operation: Urban, regional, and multi-purpose. The agencies are also proposing alternative standards for emergency vehicles.

The agencies project that the proposed vocational vehicle standards could be met through improvements in the engine, transmission, driveline, lower rolling resistance tires, workday idle reduction technologies, and weight reduction, plus some application of hybrid technology. These are described in Section V of this preamble and in Chapter 2.9 of the draft RIA. These MY 2027 standards would achieve up to 16 percent lower CO_2 emissions and fuel consumption than MY 2017 Phase 1 standards. The agencies are also proposing revisions to the compliance regime for vocational vehicles. These include: The addition of an idle cycle that would be weighted along with the other drive cycles; and revisions to the vehicle simulation tool to reflect specific improvements to the engine, transmission, and driveline.

Similar to the tractor program, we have determined that there is sufficient lead time to introduce many of these new technologies into the fleet starting in MY 2021. Therefore, we are proposing new standards for MY 2021 and 2024. Based on our analysis, the MY 2021 standards for vocational vehicles would achieve up to 7 percent lower CO_2 emissions and fuel consumption than a MY 2017 Phase 1 vehicle, on average, and the MY 2024 standards would achieve up to 11 percent lower CO_2 emissions and fuel consumption.

In Phase 1, EPA adopted air conditioning (A/C) refrigerant leakage standards for tractors, as well as for heavy-duty pickups and vans, but not for vocational vehicles. For Phase 2, EPA believes that it would be feasible to apply similar A/C refrigerant leakage standards for vocational vehicles, beginning with the 2021 model year. The process for certifying that low leakage components are used would follow the system currently in place for comparable systems in tractors.

TABLE I–5—SUMMARY OF PHASE 1 AND PROPOSED PHASE 2 REQUIREMENTS FOR VOCATIONAL VEHICLE CHASSIS

	Phase 1 program	Alternative 3—2027 (proposed standard)	Alternative 4—2024 (also under consideration)
Covered in this category	Class 2b–8 chassis that are intended for vocational services such as delivery vehicles, emergency vehicles, dump truck, tow trucks, cement mixer, refuse trucks, etc., except those qualified as off-highway vehicles.		
	Because of sector diversity, vocational vehicle chassis are segmented into Light, Medium and Heavy Duty vehicle categories and for Phase 2 each of these segments are further subdivided using three duty cycles: Regional, Multi-purpose, and Urban.		
Share of HDV fuel consumption and GHG emissions.	Vocational vehicles account for approximately 20 percent of fuel use and GHG emissions in the medium and heavy duty truck sector categories.		
Per vehicle fuel consumption and CO_2 improvement.	2% improvement over MY 2010 baseline. Improvements are in addition to improvements from engine standards.	Up to 16% improvement over MY 2017 standards.	
Form of the standard	EPA: CO_2 grams/ton payload mile and NHTSA: Gallons of fuel/1,000 ton payload mile.		
Example technology options available to help manufacturers meet standards.	Low rolling resistance tires	Further technology improvements and increased use of Phase 1 technologies, plus improved engines, transmissions and axles, powertrain optimization, weight reduction, hybrids, and workday idle reduction systems.	

TABLE I–5—SUMMARY OF PHASE 1 AND PROPOSED PHASE 2 REQUIREMENTS FOR VOCATIONAL VEHICLE CHASSIS—Continued

	Phase 1 program	Alternative 3—2027 (proposed standard)	Alternative 4—2024 (also under consideration)
Flexibilities	ABT program which allows emissions and fuel consumption credits to be averaged, banked, or traded (five year credit life). Manufacturers allowed to carry-forward credit deficits for up to three model years. Interim incentives for advanced technologies, recognition of innovative (off-cycle) technologies not accounted for by the HD Phase 1 test procedures, and credits for certifying early.	Same as Phase 1, except no advanced technology incentives.	
		Chassis intended for emergency vehicles have proposed Phase 2 standards based only on Phase 1 technologies, and may continue to certify using a simplified Phase 1-style GEM tool. Adjustment factor of 1.36 proposed for credits carried forward from Phase 1 to Phase 2 due to proposed change in useful life.	

(e) Summary of the Proposed Heavy-Duty Pickup and Van Standards

The agencies are proposing to adopt new Phase 2 GHG emission and fuel consumption standards for heavy-duty pickups and vans that would be applied in largely the same manner as the Phase 1 standards. These standards are based on the extensive use of most known and proven technologies, and could result in some use of strong hybrid powertrain technology. These proposed standards would commence in MY 2021. Overall, the proposed standards are 16 percent more stringent by 2027.

TABLE I–6—SUMMARY OF PHASE 1 AND PROPOSED PHASE 2 REQUIREMENTS FOR HD PICKUPS AND VANS

	Phase 1 program	Alternative 3—2027 (proposed standard)	Alternative 4—2025 (also under consideration)
Covered in this category	Class 2b and 3 complete pickup trucks and vans, including all work vans and 15-passenger vans but excluding 12-passenger vans which are subject to light-duty standards.		
Share of HDV fuel consumption and GHG emissions.	HD pickups and vans account for approximately 15% of fuel use and GHG emissions in the medium and heavy duty truck sector.		
Per vehicle fuel consumption and CO_2 improvement.	15% improvement over MY 2010 baseline for diesel vehicles, and 10% improvement for gasoline vehicles.	16% improvement over MY 2018–2020 standards.	
Form of the standard	Phase 1 standards are based upon a "work factor" attribute that combines truck payload and towing capabilities, with an added adjustment for 4-wheel drive vehicles. There are separate target curves for diesel-powered and gasoline-powered vehicles. As proposed, the Phase 2 standards would be based on the same approach.		
Example technology options available to help manufacturers meet standards.	Engine improvements, transmission improvements, aerodynamic drag improvements, low rolling resistance tires, weight reduction, and improved accessories.	Further technology improvements and increased use of all Phase 1 technologies, plus engine stop-start, and powertrain hybridization (mild and strong).	

TABLE I–6—SUMMARY OF PHASE 1 AND PROPOSED PHASE 2 REQUIREMENTS FOR HD PICKUPS AND VANS—Continued

	Phase 1 program	Alternative 3—2027 (proposed standard)	Alternative 4—2025 (also under consideration)
Flexibilities	Two optional phase-in schedules; ABT program which allows emissions and fuel consumption credits to be averaged, banked, or traded (five year credit life). Manufacturers allowed to carry-forward credit deficits for up to three model years. Interim incentives for advanced technologies, recognition of innovative (off-cycle) technologies not accounted for by the HD Phase 1 test procedures, and credits for certifying early.	Proposed to be same as Phase 1, with phase-in schedule based on year-over-year increase in stringency. Adjustment factor of 1.25 proposed for credits carried forward from Phase 1 to Phase 2 due to proposed change in useful life. Proposed cessation of advanced technology incentives in 2021 and continuation of off-cycle credits.	

(f) Summary of the Proposed Final Numeric Standards by Regulatory Subcategory

Table I–7 lists the proposed final (*i.e.,* MY 2027) numeric standards by regulatory subcategory for tractors, trailers, vocational vehicles and engines. Note that these are the same final numeric standards for Alternative 4, but for Alternative 4 these would be implemented in MY 2024 instead of MY 2027.

TABLE I–7—PROPOSED FINAL (MY 2027) NUMERIC STANDARDS BY REGULATORY SUBCATEGORY

Regulatory subcategory	CO_2 grams per ton-mile (for engines CO_2 grams per brake horsepower-hour)	Fuel consumption gallon per 1,000 ton-mile (for engines gallons per 100 brake horsepower-hour)
Tractors:.		
Class 7 Low Roof Day Cab	87	8.5462
Class 7 Mid Roof Day Cab	96	9.4303
Class 7 High Roof Day Cab	96	9.4303
Class 8 Low Roof Day Cab	70	6.8762
Class 8 Mid Roof Day Cab	76	7.4656
Class 8 High Roof Day Cab	76	7.4656
Class 8 Low Roof Sleeper Cab	62	6.0904
Class 8 Mid Roof Sleeper Cab	69	6.7780
Class 8 High Roof Sleeper Cab	67	6.5815
Trailers:		
Long Dry Box Trailer	77	7.5639
Short Dry Box Trailer	140	13.7525
Long Refrigerated Box Trailer	80	7.8585
Short Refrigerated Box Trailer	144	14.1454
Vocational Diesel:		
LHD Urban	272	26.7191
LHD Multi-Purpose	280	27.5049
LHD Regional	292	28.6837
MHD Urban	172	16.8959
MHD Multi-Purpose	174	17.0923
MHD Regional	170	16.6994
HHD Urban	182	17.8782
HHD Multi-Purpose	183	17.9764
HHD Regional	174	17.0923
Vocational Gasoline:		
LHD Urban	299	33.6446
LHD Multi-Purpose	308	34.6574
LHD Regional	321	36.1202
MHD Urban	189	21.2670
MHD Multi-Purpose	191	21.4921
MHD Regional	187	21.0420
HHD Urban	196	22.0547
HHD Multi-Purpose	198	22.2797
HHD Regional	188	21.1545
Diesel Engines:		
LHD Vocational	553	5.4322
MHD Vocational	553	5.4322
HHD Vocational	533	5.2358
MHD Tractor	466	4.5776

TABLE I–7—PROPOSED FINAL (MY 2027) NUMERIC STANDARDS BY REGULATORY SUBCATEGORY—Continued

Regulatory subcategory	CO_2 grams per ton-mile (for engines CO_2 grams per brake horsepower-hour)	Fuel consumption gallon per 1,000 ton-mile (for engines gallons per 100 brake horsepower-hour)
HHD Tractor	441	4.3320

Similar to Phase 1 the agencies are proposing for Phase 2 a set of continuous equation-based standards for HD pickups and vans. Please refer to Section 6, subsection B.1, for a description of these standards, including associated tables and figures.

D. Summary of the Costs and Benefits of the Proposed Rule

This section summarizes the projected costs and benefits of the proposed NHTSA fuel consumption and EPA GHG emission standards, along with those of Alternative 4. These projections helped to inform the agencies' choices among the alternatives considered, along with other relevant factors, and NHTSA's Draft Environmental Impact Statement (DEIS). See Sections VII through IX and the Draft RIA for additional details about these projections.

For this rule, the agencies conducted coordinated and complementary analyses using two analytical methods for the heavy-duty pickup and van segment by employing both DOT's CAFE model and EPA's MOVES model. The agencies used EPA's MOVES model to estimate fuel consumption and emissions impacts for tractor-trailers (including the engine that powers the tractor), and vocational vehicles (including the engine that powers the vehicle). Additional calculations were performed to determine corresponding monetized program costs and benefits. For heavy-duty pickups and vans, the agencies performed complementary analyses, which we refer to as ''Method A'' and ''Method B.'' In Method A, the CAFE model was used to project a pathway the industry could use to comply with each regulatory alternative and the estimated effects on fuel consumption, emissions, benefits and costs. In Method B, the CAFE model was used to project a pathway the industry could use to comply with each regulatory alternative, along with resultant impacts on per vehicle costs, and the MOVES model was used to calculate corresponding changes in total fuel consumption and annual emissions. Additional calculations were performed to determine corresponding monetized program costs and benefits. NHTSA considered Method A as its central analysis and Method B as a supplemental analysis. EPA considered the results of both methods. The agencies concluded that both methods led the agencies to the same conclusions and the same selection of the proposed standards. See Section VII for additional discussion of these two methods.

(1) Reference Case Against Which Costs and Benefits Are Calculated

The No Action Alternative for today's analysis, alternatively referred to as the ''baseline'' or ''reference case,'' assumes that the agencies would not issue new rules regarding MD/HD fuel efficiency and GHG emissions. This is the baseline against which costs and benefits for the proposed standards are calculated. The reference case assumes that model year 2018 standards would be extended indefinitely and without change.

The agencies recognize that if the proposed rule is not adopted, manufacturers will continue to introduce new heavy-duty vehicles in a competitive market that responds to a range of factors. Thus manufacturers might have continued to improve technologies to reduce heavy-duty vehicle fuel consumption. Thus, as described in Section VII, both agencies fully analyzed the proposed standards and the regulatory alternatives against two reference cases. The first case uses a baseline that projects very little improvement in new vehicles in the absence of new Phase 2 standards, and the second uses a more dynamic baseline that projects more significant improvements in vehicle fuel efficiency. NHTSA considered its primary analysis to be based on the more dynamic baseline, where certain cost-effective technologies are assumed to be applied by manufacturers to improve fuel efficiency beyond the Phase 1 requirements in the absence of new Phase 2 standards. EPA considered both reference cases. The results for all of the regulatory alternatives relative to both reference cases, derived via the same methodologies discussed in this section, are presented in Section X of the preamble.

The agencies chose to analyze these two different baselines because the agencies recognize that there are a number of factors that create uncertainty in projecting a baseline against which to compare the future effects of the proposed action and the remaining alternatives. The composition of the future fleet—such as the relative position of individual manufacturers and the mix of products they each offer—cannot be predicted with certainty at this time. Additionally, the heavy-duty vehicle market is diverse, as is the range of vehicle purchasers. Heavy-duty vehicle manufacturers have reported that their customers' purchasing decisions are influenced by their customers' own determinations of minimum total cost of ownership, which can be unique to a particular customer's circumstances. For example, some customers (*e.g.,* less-than-truckload or package delivery operators) operate their vehicles within a limited geographic region and typically own their own vehicle maintenance and repair centers within that region. These operators tend to own their vehicles for long time periods, and sometimes for the entire service life of the vehicle. Their total cost of ownership is influenced by their ability to better control their own maintenance costs, and thus they can afford to consider fuel efficiency technologies that have longer payback periods, outside of the vehicle manufacturer's warranty period. Other customers (*e.g.* truckload or long-haul operators) tend to operate cross-country, and thus must depend upon truck dealer service centers for repair and maintenance. Some of these customers tend to own their vehicles for about four to seven years, so that they typically do not have to pay for repair and maintenance costs outside of either the manufacturer's warranty period or some other extended warranty period. Many of these customers tend to require seeing evidence of fuel efficiency technology payback periods on the order of 18 to 24 months before seriously considering evaluating a new technology for potential adoption within their fleet (NAS 2010, Roeth et al. 2013, Klemick et al. 2014). Purchasers of HD pickups and vans wanting better fuel efficiency tend to demand that fuel consumption improvements pay back within approximately one to three years, but some HD pickup and van owners accrue relatively few vehicle miles traveled per year, such that they may be less likely to adopt new fuel efficiency technologies, while other owners who use their vehicle(s) with greater intensity may be even more willing to pay for fuel efficiency improvements. Regardless of the type of customer, their determination of minimum total cost of ownership involves the customer balancing their own unique circumstances with a heavy-duty vehicle's initial purchase price, availability of credit and lease options, expectations of vehicle reliability, resale value and fuel efficiency technology payback periods. The degree of the incentive to adopt additional fuel efficiency technologies also depends on customer expectations of future fuel prices, which directly impacts customer payback periods. Purchasing decisions are not based exclusively on payback period, but also include the considerations discussed above and in Section X.A.1. For the baseline analysis, the agencies use payback period as a proxy for all of these considerations, and therefore the payback period for the baseline analysis is shorter than the payback period industry uses as a threshold for the further consideration of a technology. The agencies request comment on which alternative baseline scenarios would be most appropriate for analysis in the final rule. Specifically, the agencies request empirical evidence to support whether the agencies should use for the final rule the central cases used in this proposal, alternative sensitivity cases such as those mentioned below, or some other scenarios. See Section X.A.1of this Preamble and Chapter 11 of the draft RIA for a more detailed discussion of baselines.

As part of a sensitivity analysis, additional baseline scenarios were also evaluated for HD pickups and vans, including baseline payback periods of 12, 18 and 24 months. See Section VI of this Preamble and Chapter 10 of the draft RIA for a detailed discussion of these additional scenarios.

(2) Costs and Benefits Projected for the Standards Being Proposed and Alternative 4

The tables below summarize the benefits and costs for the program in two ways: First, from the perspective of a program designed to improve the Nation's energy security and to conserve energy by improving fuel efficiency and then from the perspective of a program designed to reduce GHG emissions. The individual categories of benefits and costs presented in the tables below are defined more fully and presented in more detail in Chapter 8 of the draft RIA.

Table I–8 shows benefits and costs for the proposed standards and Alternative 4 from the perspective of a program designed to improve the Nation's energy security and conserve energy by improving fuel efficiency. From this viewpoint, technology costs occur when the vehicle is purchased. Fuel savings are counted as benefits that occur over the lifetimes of the vehicles produced during the model years subject to the Phase 2 standards as they consume less fuel.

TABLE I–8—LIFETIME FUEL SAVINGS, GHG REDUCTIONS, BENEFITS, COSTS AND NET BENEFITS FOR MODEL YEARS 2018–2029 VEHICLES USING ANALYSIS METHOD A

[Billions of 2012$] [a b]

Category	Alternative			
	3 Preferred		4	
	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate
Fuel Reductions (Billion Gallons)	72.2–76.7		81.9–86.7	
GHG reductions (MMT CO_2 eq)	974–1,034		1,102–1,166	
Vehicle Program: Technology and Indirect Costs, Normal Profit on Additional Investments	25.0–25.4	16.8–17.1	32.9–34.3	22.5–23.5
Additional Routine Maintenance	1.0–1.1	0.6–0.6	1.0–1.1	0.6–0.7
Congestion, Accidents, and Noise from Increased Vehicle Use	4.5–4.7	2.6–2.8	4.7–4.9	2.7–2.8
Total Costs	30.5–31.1	20.0–20.5	38.7–40.8	25.8–27.0
Fuel Savings (valued at pre-tax prices)	165.1–175.1	89.2–94.2	187.4–198.3	102.0–107.5
Savings from Less Frequent Refueling	2.9–3.1	1.5–1.6	3.4–3.6	1.8–2.0
Economic Benefits from Additional Vehicle Use	14.7–15.1	8.2–8.4	15.0–15.4	8.4–8.6
Reduced Climate Damages from GHG Emissions [c]	32.9–34.9	32.9–34.9	37.3–39.4	37.3–39.4
Reduced Health Damages from Non-GHG Emissions	37.2–38.8	20–20.7	40.9–42.5	22.1–22.8
Increased U.S. Energy Security	8.1–8.9	4.3–4.7	9.3–10.2	5.0–5.5
Total Benefits	261–276	156–165	293–309	177–186
Net Benefits	231–245	136–144	255–269	151–159

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Range reflects two reference case assumptions 1a and 1b.

[c] Benefits and net benefits use the 3 percent global average SCC value applied only to CO_2 emissions; GHG reductions include CO_2, CH_4, N_2O and HFC reductions, and include benefits to other nations as well as the U.S. See Draft RIA Chapter 8.5 and Preamble Section IX.G for further discussion.

Table I–9 shows benefits and cost from the perspective of reducing GHG.

TABLE I–9—LIFETIME FUEL SAVINGS, GHG REDUCTIONS, BENEFITS, COSTS AND NET BENEFITS FOR MODEL YEARS 2018–2029 VEHICLES USING ANALYSIS METHOD B

[Billions of 2012$] [a b]

Category	Alternative			
	3 Preferred		4	
	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate
Fuel Reductions (Billion Gallons)	70.2 to 75.8		79.7 to 85.4	
GHG reductions (MMT CO_2eq)	960 to 1,040		1,090 to 1,160	
Vehicle Program (e.g., technology and indirect costs, normal profit on additional investments).	−$24.6 to −$25.1	−$16.3 to −$16.6	−$33.1 to −$33.5	−$22.2 to −$22.5
Additional Routine Maintenance	−$1.1 to −$1.1	−$0.6 to −$0.6	−$1.1 to −$1.1	−$0.6 to −$0.6
Fuel Savings (valued at pre-tax prices)	$159 to $171	$84.2 to $90.1	$181 to $193	$96.5 to $103
Energy Security	$8.5 to $9.3	$4.4 to $4.8	$9.8 to $10.6	$5.2 to $5.6
Congestion, Accidents, and Noise from Increased Vehicle Use	−$4.2 to −$4.3	−$2.4 to −$2.4	−$4.2 to −$4.3	−$2.4 to −$2.4
Savings from Less Frequent Refueling	$2.8 to $3.1	$1.4 to $1.6	$3.3 to $3.6	$1.7 to $1.9
Economic Benefits from Additional Vehicle Use	$14.8 to $14.9	$8.2 to $8.2	$14.7 to $14.8	$8.1 to $8.1
Benefits from Reduced Non-GHG Emissions [c]	$37.4 to $39.7	$17.7 to $18.8	$41.2 to $43.5	$19.7 to $20.7
Reduced Climate Damages from GHG Emissions [d]	$31.6 to $34.0		$35.9 to $38.3	
Net Benefits	$224 to $242	$128 to $138	$248 to $265	$142 to $152

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Range reflects two baseline assumptions 1a and 1b.

[c] Range reflects both the two baseline assumptions 1a and 1b using the mid-point of the low and high $/ton estimates for calculating benefits.

[d] Benefits and net benefits use the 3 percent average SCCO2 value applied only to CO_2 emissions; GHG reductions include CO_2, CH_4 and N_2O reductions.

Table I–10 breaks down by vehicle category the benefits and costs for the proposed standards and Alternative 4 using the Method A analytical approach. For additional detail on per-vehicle break-downs of costs and benefits, please see Chapter 10.

TABLE I–10—PER VEHICLE CATEGORY LIFETIME FUEL SAVINGS, GHG REDUCTIONS, BENEFITS, COSTS AND NET BENEFITS FOR MODEL YEARS 2018–2029 VEHICLES USING ANALYSIS METHOD A (BILLIONS OF 2012$), RELATIVE TO BASELINE 1b [a]

Key costs and benefits by vehicle category	Alternative			
	3 Preferred		4	
	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate
Tractors, Including Engines, and Trailers:.				
Fuel Reductions (Billion Gallons)	56.1		61.6	
GHG Reductions (MMT CO_2 eq)	731.1		803.1	
Total Costs	15.2	10.0	17.7	11.9
Total Benefits	177.8	105.4	194.2	115.7
Net Benefits	162.6	95.4	176.5	103.9
Vocational Vehicles, Including Engines:				
Fuel Reductions (Billion Gallons)	8.3		10.9	
GHG Reductions (MMT CO_2 eq)	107.0		139.8	
Total Costs	9.5	6.1	12.8	8.4
Total Benefits	27.7	16.0	35.0	20.6
Net Benefits	18.1	9.9	22.1	12.1
HD Pickups and Vans:				
Fuel Reductions (Billion Gallons)	7.8		9.3	
GHG Reductions (MMT CO_2 eq)	94.1		112.8	
Total Costs	5.5	3.7	7.8	5.3

TABLE I–10—PER VEHICLE CATEGORY LIFETIME FUEL SAVINGS, GHG REDUCTIONS, BENEFITS, COSTS AND NET BENEFITS FOR MODEL YEARS 2018–2029 VEHICLES USING ANALYSIS METHOD A (BILLIONS OF 2012$), RELATIVE TO BASELINE 1b [a]—Continued

Key costs and benefits by vehicle category	Alternative			
	3 Preferred		4	
	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate
Total Benefits	23.5	14.1	28.3	17.1
Net Benefits	18.0	10.5	20.4	11.9

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE I–11—PER VEHICLE COSTS RELATIVE TO BASELINE 1a

	3 Proposed standards			4	
	MY 2021	MY 2024	MY 2027	MY 2021	MY 2024
Per Vehicle Cost ($) [a]					
Tractors	$6,710	$9,940	$11,700	$10,200	$12,400
Trailers	900	1,010	1,170	1,080	1,230
Vocational Vehicles	1,150	1,770	3,380	1,990	3,590
Pickups/Vans	520	950	1,340	1,050	1,730

Note:

[a] Per vehicle costs include new engine and vehicle technology only; costs associated with increased insurance, taxes and maintenance are included in the payback period values.

An important metric to vehicle purchasers is the payback period that can be expected on any new purchase. In other words, there is greater willingness to pay for new technology if that new technology ''pays back'' within an acceptable period of time. The agencies make no effort to define the acceptable period of time, but seek to estimate the payback period for others to make the decision themselves. The payback period is the point at which reduced fuel expenditures outpace increased vehicle costs, including increased maintenance, insurance premiums and taxes. The payback periods for vehicles meeting the standards considered for the final year of implementation (MY2024 for alternative 4 and MY2027 for the proposed standards) are shown in Table I–12, and are similar for both Method A and Method B.

TABLE I–12—PAYBACK PERIODS FOR MY2027 VEHICLES UNDER THE PROPOSED STANDARDS AND FOR MY2024 VEHICLES UNDER ALTERNATIVE 4 RELATIVE TO BASELINE 1a

[Payback occurs in the year shown; using 7% discounting]

	Proposed standards	Alternative 4
Tractors/Trailers	2nd	2nd
Vocational Vehicles	6th	6th
Pickups/Vans	3rd	4th

(3) Cost Effectiveness

These proposed regulations implement Section 32902(k) of EISA and Section 202(a)(1) and (2) of the Clean Air Act. Through the 2007 EISA, Congress directed NHTSA to create a medium- and heavy-duty vehicle fuel efficiency program designed to achieve the maximum feasible improvement by considering appropriateness, cost-effectiveness, and technological feasibility to determine maximum feasible standards.[62] The Clean Air Act requires that any air pollutant emission standards for heavy-duty vehicles and engines take into account the costs of any requisite technology and the lead time necessary to implement such technology. Both agencies considered overall costs, overall benefits and cost effectiveness in developing the Phase 1 standards. Although there are different ways to evaluate cost effectiveness, the essence is to consider some measure of costs relative to some measure of impacts.

Considering that Congress enacted EPCA and EISA to, among other things, address the need to conserve energy, the agencies have evaluated the proposed standards in terms of costs per gallon of fuel conserved. As described in the draft RIA, the agencies also evaluated the

[62] This EISA requirement applies to regulation of medium- and heavy-duty vehicles. For many years, and as reaffirmed by Congress in 2007, ''economic practicability'' has been among the factors EPCA requires NHTSA to consider when setting light-duty fuel economy standards at the (required) maximum feasible levels. NHTSA interprets ''economic practicability'' as a factor involving considerations broader than those likely to be involved in ''cost effectiveness''.

proposed standards using the same approaches employed in HD Phase 1. Together, the agencies have considered the following three ratios of cost effectiveness:

1. Total costs per gallon of fuel conserved.

2. Technology costs per ton of GHG emissions reduced.

3. Technology costs minus fuel savings per ton of GHG emissions reduced.

By all three of these measures, the proposed standards would be highly cost effective.

As discussed below, the agencies estimate that over the lifetime of heavy-duty vehicles produced for sale in the U.S. during model years 2018–2029, the proposed standards would cost about $30 billion and conserve about 75 billion gallons of fuel, such that the first measure of cost effectiveness would be about 40 cents per gallon. Relative to fuel prices underlying the agencies' analysis, the agencies have concluded that today's proposed standards would be cost effective.

With respect to the second measure, which is useful for comparisons to other GHG rules, the proposed standards would have overall $/ton costs similar to the HD Phase 1 rule. As Chapter 7 of the draft RIA shows, technology costs by themselves would amount to less than $50 per metric ton of GHG (CO_2 eq) for the entire HD Phase 2 program. This compares well to both the HD Phase 1 rule, which was estimated to cost about $30 per metric ton of GHG (without fuel savings), and to the agencies' estimates of the social cost of carbon. Thus, even without accounting for fuel savings, the proposed standards would be cost-effective.

The third measure deducts fuel savings from technology costs, which also is useful for comparisons to other GHG rules. On this basis, net costs per ton of GHG emissions reduced would be negative under the proposed standards. This means that the value of the fuel savings would be greater than the technology costs, and there would be a net cost saving for vehicle owners. In other words, the technologies would pay for themselves (indeed, more than pay for themselves) in fuel savings.

In addition, while the net economic benefits (*i.e.,* total benefits minus total costs) of the proposed standards is not a traditional measure of their cost-effectiveness, the agencies have concluded that the total costs of the proposed standards are justified in part by their significant economic benefits. As discussed in the previous subsection and in Section IX, this rule would provide benefits beyond the fuel conserved and GHG emissions avoided. The rule's net benefits is a measure that quantifies each of its various benefits in economic terms, including the economic value of the fuel it saves and the climate-related damages it avoids, and compares their sum to the rule's estimated costs. The agencies estimate that the proposed standards would result in net economic benefits exceeding $100 billion, making this a highly beneficial rule.

Our current analysis of Alternative 4 also shows that, if technologically feasible, it would have similar cost-effectiveness but with greater net benefits (see Chapter 11 of the draft RIA). For example, the agencies estimate costs under Alternative 4 could be about $40 billion and about 85 billion gallons of fuel could be conserved, such that the first measure of cost effectiveness would be about 47 cents per gallon. However, the agencies considered all of the relevant factors, not just relative cost-effectiveness, when selecting the proposed standards from among the alternatives considered. Relative cost-effectiveness was not a limiting factor for the agencies in selecting the proposed standards. It is also worth noting that the proposed standards and the Alternative 4 standards appear very cost effective, regardless of which reference case is used for the baseline, such that all of the analyses reinforced the agencies' findings.

E. EPA and NHTSA Statutory Authorities

This section briefly summarizes the respective statutory authority for EPA and NHTSA to promulgate the Phase 1 and proposed Phase 2 programs. For additional details of the agencies' authority, see Section XV of this notice as well as the Phase 1 rule.[63]

(1) EPA Authority

Statutory authority for the vehicle controls in this proposal is found in CAA section 202(a)(1) and (2) (which requires EPA to establish standards for emissions of pollutants from new motor vehicles and engines which emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare), and in CAA sections 202(d), 203–209, 216, and 301 (42 U.S.C. 7521 (a)(1) and (2), 7521(d), 7522–7543, 7550, and 7601).

Title II of the CAA provides for comprehensive regulation of mobile sources, authorizing EPA to regulate emissions of air pollutants from all mobile source categories. When acting under Title II of the CAA, EPA considers such issues as technology effectiveness, its cost (both per vehicle, per manufacturer, and per consumer), the lead time necessary to implement the technology, and based on this the feasibility and practicability of potential standards; the impacts of potential standards on emissions reductions of both GHGs and non-GHG emissions; the impacts of standards on oil conservation and energy security; the impacts of standards on fuel savings by customers; the impacts of standards on the truck industry; other energy impacts; as well as other relevant factors such as impacts on safety.

This proposed action implements a specific provision from Title II, Section 202(a). Section 202(a)(1) of the CAA states that ''the Administrator shall by regulation prescribe (and from time to time revise) . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles . . ., which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' With EPA's December 2009 final findings that certain greenhouse gases may reasonably be anticipated to endanger public health and welfare and that emissions of GHGs from Section 202(a) sources cause or contribute to that endangerment, Section 202(a) requires EPA to issue standards applicable to emissions of those pollutants from new motor vehicles. See *Coalition for Responsible Regulation* v. *EPA,* 684 F. 3d at 116–125, 126–27 cert. granted by, in part Util. Air Regulatory Group v. EPA, 134 S. Ct. 418, 187 L. Ed. 2d 278, 2013 U.S. LEXIS 7380 (U.S., 2013), affirmed in part and reversed in part on unrelated grounds by Util. Air Regulatory Group v. EPA, 134 S. Ct. 2427, 189 L. Ed. 2d 372, 2014 U.S. LEXIS 4377 (U.S., 2014) (upholding EPA's endangerment and cause and contribute findings, and further affirming EPA's conclusion that it is legally compelled to issue standards under Section 202 (a) to address emission of the pollutant which endangers after making the endangerment and cause of contribute findings); see also id. at 127–29 (upholding EPA's light-duty GHG emission standards for MYs 2012–2016 in their entirety).

Other aspects of EPA's legal authority, including it authority under Section 202(a), its testing authority under Section 203 of the Act, and its enforcement authorities under Section 207 of the Act are discussed fully in the Phase 1 rule, and need not be repeated here. See 76 FR 57129–57130.

[63] 76 FR 57106—57129, September 15, 2011.

The proposed rule includes GHG emission and fuel efficiency standards applicable to trailers—an essential part of the tractor-trailer motor vehicle. Class 7/8 heavy-duty vehicles are composed of three major components:—The engine, the cab-chassis (*i.e.* the tractor), and the trailer. The fact that the vehicle consists of two detachable parts does not mean that either of the parts is not a motor vehicle. The trailer's sole purpose is to serve as the cargo-hauling part of the vehicle. Without the tractor, the trailer cannot transport property. The tractor is likewise incomplete without the trailer. The motor vehicle needs both parts, plus the engine, to accomplish its intended use. Connected together, a tractor and trailer constitute ''a self-propelled vehicle designed for transporting . . . property on a street or highway,'' and thus meet the definition of ''motor vehicle'' under Section 216(2) of the CAA. Thus, as EPA has previously explained, we interpret our authority to regulate motor vehicles to include authority to regulate such trailers. See 79 FR 46259 (August 7, 2014).[64]

This analysis is consistent with definitions in the Federal regulations issued under the CAA at 40 CFR 86.1803–01, where a heavy-duty vehicle ''that has the primary load carrying device or container attached'' is referred to as a ''[c]omplete heavy-duty vehicle,'' while a heavy-duty vehicle or truck ''which does not have the primary load carrying device or container attached'' is referred to as an ''[i]ncomplete heavy-duty vehicle'' or ''[i]ncomplete truck.'' The trailers that would be covered by this proposal are properly considered ''the primary load carrying device or container'' for the heavy-duty vehicles to which they become attached for use. Therefore, under these definitions, such trailers are implicitly part of a ''complete heavy-duty vehicle,'' and thus part of a ''motor vehicle.''[65] [66] [67]

The argument that trailers do not themselves emit pollutants and so are not subject to emission standards is also unfounded. First, the argument lacks a factual predicate. Trailers indisputably contribute to the motor vehicle's CO_2 emissions by increasing engine load, and these emissions can be reduced through various means such as trailer aerodynamic and tire rolling resistance improvements. See Section IV below. The argument also lacks a legal predicate. Section 202(a)(1) authorizes standards applicable to emissions of air pollutants ''from'' either the motor vehicle or the engine. There is no requirement that pollutants be emitted from a specified part of the motor vehicle or engine. And indeed, the argument proves too much, since tractors and vocational vehicle chassis likewise contribute to emissions (including contributing by the same mechanisms that trailers do) but do not themselves directly emit pollutants. The fact that Section 202(a)(1) applies explicitly to both motor vehicles and engines likewise indicates that EPA has unquestionable authority to interpret pollutant emission caused by the vehicle component to be ''from'' the motor vehicle and so within its regulatory authority under Section 202(a)(1).[68]

(2) NHTSA Authority

The Energy Policy and Conservation Act (EPCA) of 1975 mandates a regulatory program for motor vehicle fuel economy to meet the various facets of the need to conserve energy. In December 2007, Congress enacted the Energy Independence and Security Act (EISA), amending EPCA to require, among other things, the creation of a medium- and heavy-duty fuel efficiency program for the first time.

Statutory authority for the fuel consumption standards in this proposed rule is found in EISA section 103, 49 U.S.C. 32902(k). This section authorizes a fuel efficiency improvement program, designed to achieve the maximum feasible improvement to be created for commercial medium- and heavy-duty on-highway vehicles and work trucks, to include appropriate test methods, measurement metrics, standards, and compliance and enforcement protocols that are appropriate, cost-effective and technologically feasible.

NHTSA has responsibility for fuel economy and consumption standards, and assures compliance with EISA through rulemaking, including standard-setting; technical reviews, audits and studies; investigations; and enforcement of implementing regulations including penalty actions. This proposed rule would continue to fulfill the requirements of Section 103 of EISA, which instructs NHTSA to create a fuel efficiency improvement program for ''commercial medium- and heavy-duty on-highway vehicles and work trucks'' by rulemaking, which is to include standards, test methods, measurement metrics, and enforcement protocols. *See* 49 U.S.C. 32902(k)(2).

Congress directed that the standards, test methods, measurement metrics, and compliance and enforcement protocols be ''appropriate, cost-effective, and technologically feasible'' for the vehicles to be regulated, while achieving the ''maximum feasible improvement'' in fuel efficiency. NHTSA has broad discretion to balance the statutory factors in Section 103 in developing fuel consumption standards to achieve the maximum feasible improvement.

As discussed in the Phase 1 final rule notice, NHTSA has determined that the five year statutory limit on average fuel economy standards that applies to passengers and light trucks is not applicable to the HD vehicle and engine standards. As a result, the Phase 1 HD engine and vehicle standards remain in effect indefinitely at their 2018 or 2019 MY levels until amended by a future rulemaking action. As was contemplated in that notice, NHTSA is currently engaging in this Phase 2 rulemaking action. Therefore, the Phase 1 standards would not remain in effect at their 2018 or 2019 MY levels indefinitely; they would remain in effect until the MY Phase 2 standards apply. In accordance with Section 103 of EISA, NHTSA will ensure that not less than four full MYs of regulatory lead-time and three full MYs of regulatory stability are provided for in the Phase 2 standards.

(a) Authority To Regulate Trailers

As contemplated in the Phase 1 proposed and final rules, the agencies are proposing standards for trailers in this rulemaking. Because Phase 1 did not include standards for trailers, NHTSA did not discuss its authority for regulating them in the proposed or final rules; that authority is described here.

[64] Indeed, an argument that a trailer is not a motor vehicle because, considered (artificially) as a separate piece of equipment it is not self-propelled, applies equally to the cab-chassis—the tractor. No entity has suggested that tractors are not motor vehicles; nor is such an argument plausible.

[65] We note further, however, that certain hauled items, for example a boat, would not be considered to be a trailer under the proposal. See proposed section 1037.801, proposing to define ''trailer' as being ''designed for cargo and for being drawn by a tractor.''

[66] This concept is likewise reflected in the definition of ''tractor'' in the parallel Department of Transportation regulations: ''a truck designed primarily for drawing other motor vehicles and not so constructed as to carry a load other than a part of the weight of the vehicle and the load so drawn.'' See 49 CFR 571.3.

[67] EPA's proposed definition of ''vehicle'' in 40 CFR 1037.801 makes clear that an incomplete trailer becomes a vehicle (and thus subject to the prohibition against introduction into commerce without a certificate) when it has a frame with axles attached. Complete trailers are also vehicles.

[68] This argument applies equally to emissions of criteria pollutants, whose rate of emission is likewise affected by vehicle characteristics. It is for this reason that EPA's implementing rules for criteria pollutants from heavy duty vehicles and engines specify a test weight for certification testing, since that weight influences the amount of pollution emission.

EISA directs NHTSA to ''determine in a rulemaking proceeding how to implement a commercial medium- and heavy-duty on-highway vehicle and work truck fuel efficiency improvement program designed to achieve the maximum feasible improvement. . . .'' EISA defines a commercial medium- and heavy-duty on-highway vehicle to mean ''an on-highway vehicle with a GVWR of 10,000 lbs or more.'' A ''work truck'' is defined as a vehicle between 8,500 and 10,000 lbs GVWR that is not an MDPV. These definitions do not explicitly exclude trailers, in contrast to MDPVs. Because Congress did not act to exclude trailers when defining GVWRs, despite demonstrating the ability to exclude MDPVs, it is reasonable to interpret the provision to include them.

Both commercial medium- and heavy-duty on-highway vehicles and work trucks, though, must be vehicles in order to be regulated under this program. Although EISA does not define the term ''vehicle,'' NHTSA's authority to regulate motor vehicles under its organic statute, the Motor Vehicle Safety Act (''Safety Act''), does. The Safety Act defines a motor vehicle as ''a vehicle driven or drawn by mechanical power and manufactured primarily for use on public streets, roads, and highways. . . .'' NHTSA clearly has authority to regulate trailers under this Act as vehicles that are drawn and has exercised that authority numerous times. Given the absence of any apparent contrary intent on the part of Congress in EISA, NHTSA believes it is reasonable to interpret the term ''vehicle'' as used in the EISA definitions to have a similar meaning that includes trailers.

Furthermore, the general definition of a vehicle is something used to transport goods or persons from one location to another. A tractor-trailer is designed for the purpose of transporting goods. Therefore it is reasonable to consider all of its parts—the engine, the cab-chassis, and the trailer—as parts of a whole. As such they are all parts of a vehicle, and are captured within the definition of vehicle. As EPA describes above, the tractor and trailer are both incomplete without the other. Neither can fulfill the function of the vehicle without the other. For this reason, and the other reasons stated above, NHTSA interprets its authority to regulate commercial medium- and heavy-duty on-highway vehicles, including tractor-trailers, as encompassing both tractors and trailers.

(b) Authority To Regulate Recreational Vehicles

NHTSA did not regulate recreational vehicles as part of the Phase 1 medium- and heavy-duty fuel consumption standards, although EPA did regulate them as vocational vehicles for GHG emissions.[69] In the Phase 1 proposed rule, NHTSA interpreted ''commercial medium- and heavy duty'' to mean that recreational vehicles, such as motor homes, were not to be included within the program because recreational vehicles are not commercial. Oshkosh Corporation submitted a comment on the agency's interpretation stating that it did not match the statutory definition of ''commercial medium- and heavy-duty on-highway vehicle,'' which defines the phrase by GVWR and on-highway use. In the Phase 1 final rule NHTSA agreed with Oshkosh Corporation that the agency had effectively read words into the statutory definition. However, because recreational vehicles were not proposed in the Phase 1 proposed rule, they were not within the scope of the rulemaking and were excluded from NHTSA's standards.[70] NHTSA expressed that it would address recreational vehicles in its next rulemaking.

NHTSA is proposing that recreational vehicles be included in the Phase 2 fuel consumption standards. As discussed above, EISA prescribes that NHTSA shall set average fuel economy standards for work trucks and commercial medium-duty or heavy-duty on-highway vehicles. ''Work truck'' means a vehicle that is rated between 8,500 and 10,000 lbs GVWR and is not an MDPV. ''Commercial medium- and heavy-duty on-road highway vehicle'' means an on-highway vehicle with a gross vehicle weight rating of 10,000 lbs or more.[71] Based on the definitions in EISA, recreational vehicles would be regulated as class 2b-8 vocational vehicles. Excluding recreational vehicles from the NHTSA standards in Phase 2 could create illogical results, including treating similar vehicles differently. Moreover, including recreational vehicles under NHTSA regulations furthers the agencies' goal of one national program, as EPA regulations already cover recreational vehicles.

NHTSA is proposing that recreational vehicles be included in the Phase 2 fuel consumption standards and that early compliance be allowed for manufacturers who want to certify during the Phase 1 period.[72]

F. Other Issues

In addition to the standards being proposed, this notice discusses several other issues related to those standards. It also proposes some regulatory provisions related to the Phase 1 program, as well as amendments related to other EPA and NHTSA regulations. These other issues are summarized briefly here and discussed in greater detail in later sections.

(1) Issues Related to Phase 2

(a) Natural Gas Engines and Vehicles

This combined rulemaking by EPA and NHTSA is designed to regulate two separate characteristics of heavy duty vehicles: GHGs and fuel consumption. In the case of diesel or gasoline powered vehicles, there is a one-to-one relationship between these two characteristics. For alternatively fueled vehicles, which use no petroleum, the situation is different. For example, a natural gas vehicle that achieves approximately the same fuel efficiency as a diesel powered vehicle would emit 20 percent less CO_2; and a natural gas vehicle with the same fuel efficiency as a gasoline vehicle would emit 30 percent less CO_2. Yet natural gas vehicles consume no petroleum. In Phase 1, the agencies balanced these facts by applying the gasoline and diesel CO_2 standards to natural gas engines based on the engine type of the natural gas engine. Fuel consumption for these vehicles is then calculated according to their tailpipe CO_2 emissions. In essence, this applies a one-to-one relationship between fuel efficiency and tailpipe CO_2 emissions for all vehicles, including natural gas vehicles. The agencies determined that this approach would likely create a small balanced incentive for natural gas use. In other words, it created a small incentive for the use of natural gas engines that appropriately balanced concerns about the climate impact methane emissions against other factors such as the energy security benefits of using domestic natural gas. See 76 FR 57123. We propose to maintain this approach for Phase 2. Note that EPA is also considering natural gas in a broader context of life cycle emissions, as described in Section XI.

(b) Alternative Refrigerants

In addition to use of leak-tight components in air conditioning system

[69] EPA did not give special consideration to recreational vehicles because the CAA applies to heavy-duty motor vehicle generally.

[70] Motor homes are still subject to EPA's Phase 1 CO_2 standards for vocational vehicles.

[71] 49 U.S.C. 32901(a)(7).

[72] NHTSA did not allow early compliance for one RV manufacturer in MY 2014 that is currently complying EPA's GHG standards.

design, manufacturers could also decrease the global warming impact of refrigerant leakage emissions by adopting systems that use alternative, lower global warming potential (GWP) refrigerants, to replace the refrigerant most commonly used today, HFC–134a (R–134a). HFC–134a is a potent greenhouse gas with a GWP 1,430 times greater than that of CO_2.

Under EPA's Significant New Alternatives Policy (SNAP) Program,[73] EPA has found acceptable, subject to use conditions, three alternative refrigerants that have significantly lower GWPs than HFC–134a for use in A/C systems in newly manufactured light-duty vehicles: HFC–152a, CO_2 (R–744), and HFO–1234yf.[74] HFC–152a has a GWP of 124, HFO–1234yf has a GWP of 4, and CO_2 (by definition) has a GWP of 1, as compared to HFC–134a which has a GWP of 1,430.[75] CO_2 is nonflammable, while HFO–1234yf and HFC–152a are flammable. All three are subject to use conditions requiring labeling and the use of unique fittings, and where appropriate, mitigating flammability and toxicity. Currently, the SNAP listing for HFO–1234yf is limited to newly manufactured A/C systems in LD vehicles, whereas HFC–152a and CO_2 have been found acceptable for all motor vehicle air conditioning applications, including heavy-duty vehicles.

None of these alternative refrigerants can simply be ''dropped'' into existing HFC–134a air conditioning systems. In order to account for the unique properties of each refrigerant and address use conditions required under SNAP, changes to the systems will be necessary. Typically these changes will need to occur during a vehicle redesign cycle but could also occur during a refresh. For example, because CO_2, when used as a refrigerant, is physically and thermodynamically very different from HFC–134a and operates at much higher pressures, a transition to this refrigerant would require significant hardware changes. A transition to A/C systems designed for HFO–1234yf, which is more thermodynamically similar to HFC–134a than is CO_2, requires less significant hardware changes that typically include installation of a thermal expansion valve and could potentially require resized condensers and evaporators, as well as changes in other components. In addition, vehicle assembly plants require re-tooling in order to handle new refrigerants safely. Thus a change in A/C refrigerants requires significant engineering, planning, and manufacturing investments.

EPA is not aware of any significant development of A/C systems designed to use alternative refrigerants in heavy-duty vehicles;[76] however, all three lower GWP alternatives are in use or under various stages of development for use in LD vehicles. Of these three refrigerants, most manufacturers of LD vehicles have identified HFO–1234yf as the most likely refrigerant to be used in that application. For that reason, EPA would anticipate that HFO–1234yf could be a primary candidate for refrigerant substitution in the HD market in the future if it is listed as an acceptable substitute under SNAP for HD A/C applications. EPA has begun, but has not yet completed, our evaluation of the use of HFO–1234yf in HD vehicles. After EPA has conducted a full evaluation based on the SNAP program's comparative risk framework, EPA will list this alternative as either a) acceptable subject to use conditions or b) unacceptable if the risk of use in HD A/C systems is determined to be greater than that of the other currently or potentially available alternatives. EPA is also considering and evaluating additional refrigerant substitutes for use in motor vehicle A/C systems under the SNAP program. EPA welcomes comments related to industry development of HD A/C systems using lower-GWP refrigerants.

LD vehicle manufacturers are currently making investments in systems designed for lower-GWP refrigerants, both domestically and on a global basis. In support of the LD GHG rule, EPA projected a full transition of LD vehicles to lower-GWP alternatives in the United States by MY 2021. We expect the investment required to transition to ease over time as alternative refrigerants are adopted across all LD vehicles and trucks. This may occur in part due to increased availability of components and the continuing increases in refrigerant production capacity, as well as knowledge gained through experience. As lower-GWP alternatives become widely used in LD vehicles, some manufacturers may wish to also transition their HD vehicles. Transitioning could be advantageous for a variety of reasons including platform standardization and company environmental stewardship policies.

Although manufacturers of HD vehicles may begin to transition to alternative refrigerants in the future, there is great uncertainty about when significant adoption of alternative refrigerants for HD vehicles might begin, on what timeline adoption might become widespread, and which refrigerants might be involved. Another factor is that the most likely candidate, HFO–1234yf, remains under evaluation and has not yet been listed under SNAP. For these reasons, EPA has not attempted to project any specific hypothetical scenarios of transition for analytical purposes in this proposed rule.

Because future introduction of and transition to lower-GWP alternative refrigerants for HD vehicles may occur, EPA is proposing regulatory provisions that would be in place if and when such alternatives become available and manufacturers of HD vehicles choose to use them. These proposed provisions would also have the effect of easing the burden associated with complying with the lower-leakage requirements when a lower-GWP refrigerant is used instead of HFC–134a. These provisions would recognize that leakage of refrigerants would be relatively less damaging from a climate perspective if one of the lower-GWP alternatives is used. Specifically, EPA is proposing to allow a manufacturer to be ''deemed to comply'' with the leakage standard by using a lower-GWP alternative refrigerant. In order to be ''deemed to comply'' the vehicle manufacturer would need to use a refrigerant other than HFC–134a that is listed as an acceptable substitute refrigerant for heavy-duty A/C systems under SNAP, and defined under the LD GHG regulations at 40 CFR 86.1867–12(e). The refrigerants currently defined at 40 CFR 86.1867–12(e), besides HFC–134a, are HFC–152a, HFO–1234yf, and CO_2. If a manufacturer chooses to use a lower-GWP refrigerant that is listed in the future as acceptable in 40 CFR part 82, subpart G, but that is not identified in 40 CFR 86.1867–12(e), then the manufacturer could contact EPA about how to appropriately determine compliance with the leakage standard.

EPA encourages comment on all aspects of our proposed approach to HD

[73] Section 612(c) of the Clean Air Act requires EPA to review substitutes for class I and class II ozone-depleting substances and to determine whether such substitutes pose lower risk than other available alternatives. EPA is also required to publish lists of substitutes that it determines are acceptable and those it determines are unacceptable. See *http://www.epa.gov/ozone/snap/refrigerants/lists/index.html*, last accessed on March 5, 2015.

[74] Listed at 40 CFR part 82, subpart G.

[75] GWP values cited in this proposal are from the IPCC Fourth Assessment Report (AR4) unless stated otherwise. Where no GWP is listed in AR4, GWP values shall be determined consistent with the calculations and analysis presented in AR4 and referenced materials.

[76] To the extent that some manufacturers produce HD pickups and vans on the same production lines or in the same facilities as LD vehicles, some A/C system technology commonality between the two vehicle classes may be developing.

vehicle refrigerant leakage and the potential future use of alternative refrigerants for HD applications. We specifically request comment on whether there should be additional provisions that could prevent or discourage manufacturers that transition to an alternative refrigerant from discontinuing existing, low-leak A/C system components and instead reverting to higher-leakage components.

Recently, EPA proposed to change the SNAP listing for the refrigerant HFC–134a from acceptable (subject to use conditions) to unacceptable for use in A/C systems in new LD vehicles.[77] EPA expects to take final action on this proposed change in listing status for HFC–134a for use in new, light-duty vehicles in 2015. If the final action changes the status of HFC–134a to unacceptable, it would establish a future compliance date by which HFC–134a could no longer be used in A/C systems in newly manufactured LD vehicles; instead, all A/C systems in new LD vehicles would be required to use HFC–152a, HFO–1234yf, CO_2, or any other alternative listed as acceptable for this use in the future. The current proposed rule does not address the use of HFC–134a in heavy-duty vehicles; however, EPA could consider a change of listing status for HFC–134a use in HD vehicles in the future if EPA determines that other alternatives are currently or potentially available that pose lower overall risk to human health and the environment.

(c) Small Business Issues

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. See generally 5 U.S.C. Sections 601–612. The RFA analysis is discussed in Section XIV.

Pursuant to Section 609(b) of the RFA, as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA), EPA also conducted outreach to small entities and convened a Small Business Advocacy Review Panel to obtain advice and recommendations of representatives of the small entities that potentially would be subject to the rule's requirements. Consistent with the RFA/SBREFA requirements, the Panel evaluated the assembled materials and small-entity comments on issues related to elements of the IRFA. A copy of the Panel Report is included in the docket for this proposed rule.

The agencies determined that the proposed Phase 2 regulations could have a significant economic impact on small entities. Specifically, the agencies identified four categories of directly regulated small businesses that could be impacted:

- Trailer Manufacturers
- Alternative Fuel Converters
- Vocational Chassis Manufacturers
- Glider Vehicle[78] Assemblers

To minimize these impacts the agencies are proposing certain regulatory flexibilities—both general and category-specific. In general, we are proposing to delay new requirements for EPA GHG emission standards by one year and simplify certification requirements for small businesses. For the proposed trailers standards, small businesses would be required to comply with EPA's standards before NHTSA's fuel efficiency standards would begin. NHTSA does not believe that providing small businesses trailer manufacturers with an additional year of delay to comply with those fuel efficiency standards would provide beneficial flexibility. The agencies are also proposing the following specific relief:

- Trailers: Proposing simpler requirements for non-box trailers, which are more likely to be manufactured by small businesses; and making third-party testing easier for certification.
- Alternative Fuel Converters: Omitting recertification of a converted vehicle when the engine is converted and certified; reduced N_2O testing; and simplified onboard diagnostics and delaying required compliance with each new standard by one model year.
- Vocational Chassis: Less stringent standards for certain vehicle categories.
- Glider Vehicle Assemblers:[79] Exempt existing small businesses, but limit the small business exemption to a capped level of annual production (production in excess of the capped amount would be allowed, but subject to all otherwise applicable requirements including the Phase 2 standards).

These flexibilities are described in more detail in Section XIV and in the Panel Report. The agencies look forward to comments and to feedback from the small business community before finalizing the rule and associated flexibilities to protect small businesses.

(d) Confidentiality of Test Results and GEM Inputs

In accordance with Federal statutes, EPA does not release information from certification applications (or other compliance reports) that we determine to be confidential business information (CBI) under 40 CFR part 2. Consistent with the CAA, EPA does not consider emission test results to be CBI after introduction into commerce of the certified engine or vehicle. (However, we have generally treated test results as protected before the introduction into commerce date). For Phase 2, we expect to continue this policy and thus would not treat any test results or other GEM inputs as CBI after the introduction into commerce date as identified by the manufacturer. We request comment on this approach.

We consider this issue to be especially relevant for tire rolling resistance measurements. Our understanding is that tire manufacturers typically consider such results as proprietary. However, under EPA's policy, tire rolling resistance measurements are not considered to be CBI and can be released to the public after the introduction into commerce date identified by the manufacturer. We request comment on whether EPA should release such data on a regular basis to make it easier for operators to find proper replacement tires for their vehicles.

With regard to NHTSA's treatment of confidential business information, manufacturers must submit a request for confidentiality with each electronic submission specifying any part of the information or data in a report that it believes should be withheld from public disclosure as trade secret or other confidential business information. A form will be available through the NHTSA Web site to request confidentiality. NHTSA does not consider manufacturers to continue to have a business case for protecting pre-model report data after the vehicles contained within that report have been introduced into commerce.

(e) Delegated Assembly

In EPA's existing regulations (40 CFR 1068.261), we allow engine manufacturers to sell or ship engines that are missing certain emission-related components if those components will be installed by the vehicle manufacturer. EPA has found this provision to work well for engine manufacturers and is proposing a new provision in 40 CFR

[77] See 79 FR 46126, August 6, 2014.

[78] Vehicles produced by installing a used engine into a new chassis are commonly referred to as ''gliders,'' ''glider kits,'' or ''glider vehicles,''

[79] EPA is proposing to amend its rules applicable to engines installed in glider kits, a proposal which would affect emission standards not only for GHGs but for criteria pollutants as well. EPA is also proposing to clarify its requirements for certification and revise its definitions for glider manufacturers. NHTSA is also considering including gliders under its Phase 2 standards.

1037.621 that would provide a similar allowance for *vehicle* manufacturers to sell or ship *vehicles* that are missing certain emission-related components if those components will be installed by a *secondary* vehicle manufacturer. As conditions of this allowance manufacturers would be required to:

- Have a contractual obligation with the secondary manufacturer to complete the assembly properly and provide instructions about how to do so.
- Keep records to demonstrate compliance.
- Apply a temporary label to the incomplete vehicles.
- Take other reasonable steps to ensure the assembly is completed properly.
- Describe in its application for certification how it will use this allowance.

We request comment on this allowance.

(2) Proposed Amendments to Phase 1 Program

The agencies are proposing revisions to test procedures and compliance provisions used for Phase 1. These changes are described in Section XII. As a drafting matter, EPA notes that we are proposing to migrate the GHG standards for Class 2b and 3 pickups and vans from 40 CFR 1037.104 to 40 CFR 86.1819–14. NHTSA is also proposing to amend 49 CFR part 535 to make technical corrections to its Phase 1 program to better align with EPA's compliance approach, standards and CO_2 performance results. In general, these changes are intended to improve the regulatory experience for regulated parties and also reduce agency administrative burden. More specifically, NHTSA proposes to change the rounding of its standards and performance values to have more significant digits. Increasing the number of significant digits for values used for compliance with NHTSA standards reduces differences in credits generated and overall credit balances for the NHTSA and EPA programs. NHTSA is also proposing to remove the petitioning process for off-road vehicles, clarify requirements for the documentation needed for submitting innovative technology requests in accordance with 40 CFR 1037.610 and 49 CFR 535.7, and add further detail to requirements for submitting credit allocation plans as specified in 49 CFR 535.9. Finally, NHTSA is adding the same record requirements that EPA currently requires to facilitate in-use compliance inspections. These changes are intended to improve the regulatory experience for regulated parties and also reduce agency administrative burden.

(3) Other Proposed Amendments to EPA Regulations

EPA is proposing several amendments to regulations not directly related to the HD Phase 1 or Phase 2 programs, as detailed in Section XIII. For these amendments, there would not be corresponding changes in NHTSA regulations (since there are no such regulations relevant to those programs). Some of these relate directly to heavy-duty highway engines, but not to the GHG programs. Others relate to nonroad engines. This latter category reflects the regulatory structure EPA uses for its mobile source regulations, in which regulatory provisions applying broadly to different types of mobile sources are codified in common regulatory parts such as 40 CFR part 1068. This approach creates a broad regulatory structure that regulates highway and nonroad engines, vehicles, and equipment collectively in a common program. Thus, it is appropriate to include some proposed amendments to nonroad regulations in addition to the changes proposed only for highway engines and vehicles.

(a) Standards for Engines Used In Glider Kits

EPA regulations currently allow used pre-2013 engines to be installed into new glider kits without meeting currently applicable standards. As described in Section XIV, EPA is proposing to amend our regulations to allow only engines that have been certified to meet current standards to be installed in new glider kits, with two exceptions. First, engines certified to earlier MY standards that were identical to the current model year standards may be used. Second, the small manufacturer allowance described in Section I.F.(1)(c) for glider vehicles would also apply for the engines used in the exempted glider kits.

(b) Re-Proposal of Nonconformance Penalty Process Changes

Nonconformance penalties (NCPs) are monetary penalties established by regulation that allow a vehicle or engine manufacturer to sell engines that do not meet the emission standards. Manufacturers unable to comply with the applicable standard pay penalties, which are assessed on a per-engine basis.

On September 5, 2012, EPA adopted final NCPs for heavy heavy-duty diesel engines that could be used by manufacturers of heavy-duty diesel engines unable to meet the current oxides of nitrogen (NO_X) emission standard. On December 11, 2013 the U.S. Court of Appeals for the District of Columbia Circuit issued an opinion vacating that Final Rule. It issued its mandate for this decision on April 16, 2014, ending the availability of the NCPs for the current NO_X standard, as well as vacating certain amendments to the NCP regulations due to concerns about inadequate notice. In particular, the amendments revise the text explaining how EPA determines when NCP should be made available. In this action, EPA is re-proposing most of these amendments to provide fuller notice and additional opportunity for public comment. They are discussed in Section XIV.

(c) Updates to Heavy-Duty Engine Manufacturer In-Use Testing Requirements

EPA and manufacturers have gained substantial experience with in-use testing over the last four or five years. This has led to important insights in ways that the test protocol can be adjusted to be more effective. We are accordingly proposing to make changes to the regulations in 40 CFR part 86, subparts N and T.

(d) Extension of Certain 40 CFR Part 1068 Provisions to Highway Vehicles and Engines

As part of the Phase 1 GHG standards, we applied the exemption and importation provisions from 40 CFR part 1068, subparts C and D, to heavy-duty highway engines and vehicles. We also specified that the defect reporting provisions of 40 CFR 1068.501 were optional. In an earlier rulemaking, we applied the selective enforcement auditing under 40 CFR part 1068, subpart E (75 FR 22896, April 30, 2010). We are proposing in this rule to adopt the rest of 40 CFR part 1068 for heavy-duty highway engines and vehicles, with certain exceptions and special provisions.

As described above, we are proposing to apply all the general compliance provisions of 40 CFR part 1068 to heavy-duty engines and vehicles. We propose to also apply the recall provisions and the hearing procedures from 40 CFR part 1068 for highway motorcycles and for all vehicles subject to standards under 40 CFR part 86, subpart S. We also request comment on applying the rest of the provisions from 40 CFR part 1068 to highway motorcycles and to all vehicles subject to standards under 40 CFR part 86, subpart S.

EPA is proposing to update and consolidate the regulations related to formal and informal hearings in 40 CFR part 1068, subpart G. This would allow us to rely on a single set of regulations for all the different categories of vehicles, engines, and equipment that are subject to emission standards. We also made an effort to write these regulations for improved readability.

We are also proposing to make a number of changes to part 1068 to correct errors, to add clarification, and to make adjustments based on lessons learned from implementing these regulatory provisions.

(e) Amendments to Engine and Vehicle Test Procedures in 40 CFR Parts 1065 and 1066

EPA is proposing several changes to our engine testing procedures specified in 40 CFR part 1065. None of these changes would significantly impact the stringency of any standards.

(f) Amendments Related to Marine Diesel Engines in 40 CFR Parts 1042 and 1043

EPA's emission standards and certification requirements for marine diesel engines under the Clean Air Act and the act to Prevent Pollution from Ships are identified in 40 CFR parts 1042 and 1043, respectively. EPA is proposing to amend these regulations with respect to continuous NO_X monitoring and auxiliary engines, as well as making several other minor revisions.

(g) Amendments Related to Locomotives in 40 CFR Part 1033

EPA's emission standards and certification requirements for locomotives under the Clean Air Act are identified in 40 CFR part 1033. EPA is proposing to make several minor revisions to these regulations.

(4) Other Proposed Amendments to NHTSA Regulations

NHTSA is proposing to amend 49 CFR parts 512 and 537 to allow manufacturers to submit required compliance data for the Corporate Average Fuel Economy program electronically, rather than submitting some reports to NHTSA via paper and CDs and some reports to EPA through its VERIFY database system. The agencies are coordinating on an information technology project which will allow manufacturers to submit pre-model, mid-model and final model year reports through a single electronic entry point. The agencies anticipate that this would reduce the reporting burden on manufacturers by up to fifty percent. The amendments to 49 CFR part 537 would allow reporting to an electronic database (*i.e.* EPA's VERIFY system), and the amendments to 49 CFR part 512 would ensure that manufacturer's confidential business information would be protected through that process. This proposal is discussed further in Section XIII.

II. Vehicle Simulation, Engine Standards and Test Procedures

A. Introduction and Summary of Phase 1 and Phase 2 Regulatory Structures

This Section II. A. gives an overview of our vehicle simulation approach in Phase 1 and our proposed approach for Phase 2; our separate engine standards for tractor and vocational chassis in Phase 1 and our proposed separate engine standards in Phase 2; and it describes our engine and vehicle test procedures that are common among the tractor and vocational chassis standards. Section II. B. discusses in more detail how the Phase 2 proposed regulatory structure would approach vehicle simulation, separate engine standards, and test procedures. Section II. C. discusses the proposed vehicle simulation computer program, GEM, in further detail and Section II. D. discusses the proposed separate engine standards and engine test procedure. See Sections III through VI for discussions of the proposed test procedures that are unique for tractors, trailers, vocational chassis, and HD pickup trucks and vans.

In Phase 1 the agencies adopted a regulatory structure that included a vehicle simulation procedure for certifying tractors and the chassis of vocational vehicles. In contrast, the agencies adopted a full vehicle chassis dynamometer test procedure for certifying complete heavy-duty pickups and vans. The Phase 1 vehicle simulation procedure for tractors and vocational chassis requires regulated entities to use GEM to simulate and certify tractors and vocational vehicle chassis. This program is provided free of charge for unlimited use and may be downloaded by anyone from EPA's Web site: *http://www.epa.gov/otaq/climate/gem.htm*. This computer program mathematically combines vehicle component test results with other pre-determined vehicle attributes to determine a vehicle's levels of fuel consumption and CO_2 emissions for certification purposes. For Phase 1, the required inputs to this computer program include, for tractors, vehicle aerodynamics information, tire rolling resistance, and whether or not a vehicle is equipped with certain lightweight high-strength steel or aluminum components, a tamper-proof speed limiter, or tamper-proof idle reduction technologies. The sole input for vocational vehicles, was tire rolling resistance. For Phase 1 the computer program's inputs did not include engine test results or attributes related to a vehicle's powertrain, namely, its transmission, drive axle(s), or tire revolutions per mile. Instead, for Phase 1 the agencies specified a generic engine and powertrain within the computer program, and for Phase 1 these cannot be changed by a program user.[80]

The full vehicle chassis dynamometer test procedure for heavy-duty pickups and vans substantially mirrors EPA's existing light-duty vehicle test procedure. EPA also set separate engine so-called cap standards for methane (CH_4) and nitrous oxide (N_2O) (essentially capping current emission levels). Compliance with the CH_4 and N_2O standards is measured by an engine dynamometer test procedure, which EPA based on our existing heavy-duty engine emissions test procedure with small adaptations. EPA also set hydro-fluorocarbon refrigerant leakage design standards for cabin air conditioning systems in tractors, pickups, and vans, which are evaluated by design rather than a test procedure.

In this action the agencies are proposing a similar regulatory structure for Phase 2, along with a number of revisions that are intended to more accurately evaluate vehicle and engine technologies' impact on real-world fuel efficiency and GHG emissions. Thus, we are proposing to continue the same certification test regime for heavy duty pickups and vans, and for the CH_4 and N_2O) standards, as well as tractor and pickup and van air conditioning leakage standards. EPA is also proposing to control vocational vehicle air conditioning leakage and to use that same certification procedure.

We are proposing to continue the vehicle simulation procedure for certifying tractors and vocational chassis, and we are proposing a new regulatory program to regulate some of the trailers hauled by tractors. The agencies are proposing the use of an equation based on the vehicle simulation procedure for trailer certification. In addition, we are proposing a simplified option for trailer certification that would not require testing to be undertaken by manufacturers to generate inputs for the equation. We are also proposing to continue separate fuel consumption and CO_2 standards for the engines installed

[80] These attributes are recognized in Phase 1 innovative technology provisions at 40 CFR 1037.610.

in tractors and vocational chassis, and we are proposing to continue to require a full vehicle chassis dynamometer test procedure for certifying complete heavy-duty pickups and vans. As described in Section II.B.(2)(b), the agencies see important advantages to maintaining separate engines standards, such as improved compliance assurance and better control during transient engine operation.

The vehicle simulation procedure necessitates some testing of engines and vehicle components to generate the inputs for the simulation tool; that is, to generate the inputs to the model which is used to certify tractors and vocational chassis. For trailers, some testing may be performed in order to generate values that are input into the simulation-based compliance equations. In addition to the testing needed for this purpose for the inputs used in the Phase 1 standards, the agencies are proposing in Phase 2 that manufacturers conduct additional required and optional engine and vehicle component tests, and proposing the additional procedures for conducting these input tests. These include a new required engine test procedure that provides steady-state engine fuel consumption and CO_2 inputs to represent the actual engine in a vehicle. In addition, we are seeking comment on a newly developed engine test procedure that captures transient engine performance for use in the vehicle simulation computer program. As described in detail in the draft RIA Chapter 4, we are proposing to require entering attributes that describe the vehicle's transmission type, and its number of gears and gear ratios. We are proposing an optional powertrain test procedure that would provide inputs to override the agencies' simulated engine and transmission in the vehicle simulation computer program. We are proposing to require entering attributes that describe the vehicle's drive axle(s) type and axle ratio. We are also seeking comment on an optional axle efficiency test procedure that would override the agencies' simulated axle in the vehicle simulation computer program. To improve the measurement of aerodynamic components performance, we are proposing a number of improvements to the aerodynamic coast-down test procedure and data analysis, and we are seeking comment on a newly developed constant speed aerodynamic test procedure. We are proposing that the aerodynamic test procedures for tractors be applicable to trailers when a regulated entity opts to use the GEM-based compliance equation. Additional details about all these test procedures are found in the draft RIA Chapter 3.

We are further proposing to significantly expand the number of technologies that are recognized in the vehicle simulation computer program. These include recognizing lightweight thermoplastic materials, automatic tire inflation systems, advanced cruise control systems, workday idle reduction systems, and axle configurations that decrease the number of drive axles. We are seeking comment on recognizing additional technologies such as high efficiency glass and low global warming potential air conditioning refrigerants as post-process adjustments to the simulation results.

To better reflect real-world operation, we are also proposing to revise the vehicle simulation computer program's urban (55 mph) and rural (65 mph) highway duty cycles to include changes in road grade. We are seeking comment on whether or not these duty cycles should also simulate driver behavior in response to varying traffic patterns. We are proposing a new duty cycle to capture the performance of technologies that reduce the amount of time a vehicle's engine is at idle during a workday when the vehicle is not moving. And to better recognize that vocational vehicle powertrains are configured for particular applications, we are proposing to further subdivide the vocational chassis category into three different vehicle speed categories. This is in addition to the Phase 1 subdivision by three weight categories. The result is nine proposed vocational vehicle subcategories for Phase 2. The agencies are also proposing to subdivide the highest weight class of tractors into two separate categories to recognize the unique configurations and technology applicability to ''heavy-haul'' tractors.

Even though we are proposing to include engine test results as inputs into the vehicle simulation computer model, we are also proposing to continue the Phase 1 separate engine standard regulatory structure by proposing separate engine fuel consumption and CO_2 standards for engines installed in tractors and vocational chassis. For these separate engine standards, we are proposing to continue to use the Phase 1 engine dynamometer test procedure, which was adapted substantially from EPA's existing heavy-duty engine emissions test procedure. However, we are proposing to modify the weighting factors of the tractor engine's 13-point steady-state duty cycle to better reflect real-world engine operation and to reflect the trend toward operating engines at lower engine speeds during tractor cruise speed operation. Further details on the proposed Phase 2 separate engine standards are provided below in Section II. D. In today's action EPA is proposing to continue the separate engine cap standards for methane (CH_4) and nitrous oxide (N_2O) emissions.

(1) Phase 1 Vehicle Simulation Computer Program (GEM)

For Phase 1 EPA developed a vehicle simulation computer program called, ''Greenhouse gas Emissions Model'' or ''GEM.'' GEM was created for Phase 1 for the exclusive purpose of certifying tractors and vocational vehicle chassis. GEM is similar in concept to a number of other commercially available vehicle simulation computer programs. See 76 FR 57116, 57146, and 57156–57157. However, GEM is also unique in a number of ways.

Similar to other vehicle simulation computer programs, GEM combines various vehicle inputs with known physical laws and justified assumptions to predict vehicle performance for a given period of vehicle operation. For Phase 1 GEM's vehicle inputs include vehicle aerodynamics information (for tractors), tire rolling resistance, and whether or not a vehicle is equipped with lightweight materials, a tamper-proof speed limiter, or tamper-proof idle reduction technologies. Other vehicle and engine characteristics were fixed as defaults that cannot be altered by the user. These defaults included tabulated data of engine fuel rate as a function of engine speed and torque (*i.e.* ''engine fuel maps''), transmissions, axle ratios, and vehicle payloads. For tractors, Phase 1 GEM models the vehicle pulling a standard trailer. For vocational vehicles, Phase 1 GEM includes a fixed aerodynamic drag coefficient and vehicle frontal area.

GEM uses the same physical principles as many other existing vehicle simulation models to derive governing equations which describe driveline components, engine, and vehicle. These equations are then integrated in time to calculate transient speed and torque. Some of the justified assumptions in GEM include average energy losses due to friction between moving parts of a vehicle's powertrain; the logical behavior of an average driver shifting from one transmission gear to the next; ad speed limit assumptions such as 55 miles per hour for urban highway driving and 65 miles per hour for rural interstate highway driving. The sequence of the GEM vehicle simulation can be visualized by imagining a human driver initially sitting in a parked running tractor or vocational vehicle. The driver then proceeds to drive the vehicle over a prescribed route that includes three distinct patterns of driving: Stop-and-go city driving, urban highway driving, and rural interstate highway driving. The driver then exits the highway and brings the vehicle to a stop. This concludes the vehicle simulation.

Over each of the three driving patterns or ''duty cycles,'' GEM simulates the driver's behavior of pressing the accelerator, coasting, or applying the brakes. GEM also simulates how the engine operates as the gears in the vehicle's transmission are shifted and how the vehicle's weight, aerodynamics, and tires resist the forward motion of the vehicle. GEM combines the driver behavior over the duty cycles with the various vehicle inputs and other assumptions to determine how much fuel must be consumed to move the vehicle forward at each point during the simulation. For each of the three duty cycles, GEM totals the amount of fuel consumed and then divides that amount by the product of the miles travelled and tons of payload carried. The tons of payload carried are specified by the agencies for each vehicle type and weight class. For each regulatory subcategory of tractor and vocational vehicle (*e.g.,* sleeper cab tractor, day cab tractor, small vocational vehicle, large vocational vehicle, etc.), GEM applies prescribed weighting factors to each of the three duty cycles to represent the fraction of city, urban highway, and rural highway driving that would be typical of each subcategory. After completing all the cycles, GEM outputs a single composite result for the vehicle, expressed as both fuel consumed in gallon per 1,000 ton-miles (for NHTSA standards) and an equivalent amount of CO_2 emitted in grams per ton-mile (for EPA standards). These are the vehicle's GEM results that are used along with other information to demonstrate the vehicle complies with the applicable standards. This other information includes the annual sales volume of the vehicle (family) simulated in GEM, plus information on emissions credits that may be generated or used as part of that vehicle family's certification.

While GEM is similar to other vehicle simulation computer programs, GEM is also unique in a number of ways. First, GEM was designed exclusively for regulated entities to certify tractor and vocational vehicle chassis to the agencies' respective fuel consumption and CO_2 emissions standards. For GEM to be effective for this purpose, the inputs to GEM include only information related to vehicle components and attributes that significantly impact vehicle fuel efficiency and CO_2 emissions. For example, these include vehicle aerodynamics, tire rolling resistance, and whether or not a vehicle is equipped with lightweight materials, a tamper-proof speed limiter, or tamper-proof idle reduction technologies. On the other hand, other attributes such as those related to a vehicle's suspension, frame strength, or interior features are not included, where these might be included in other commercially available vehicle simulation programs for other purposes. Furthermore, the simulated driver behavior and the duty cycles cannot be changed in the GEM executable program. This helps to ensure that all vehicles are simulated and certified in the same way, but this does preclude GEM from being of much use as a research tool for exploring the effects of driver behavior and of different duty cycles.

To allow for public comment, GEM is available free of charge for unlimited use, and the GEM source code is open source. That is, the programming source code of GEM is freely available upon request for anyone to examine, manipulate, and generally use without restriction. In contrast commercially available vehicle simulation programs are generally not free and open source. Additional details of GEM are included in Chapter 4 of the RIA.

As part of Phase 1, the agencies conducted a peer review of GEM version 1.0, which was the version released for the Phase 1 proposal.[81] [82] In response to this peer review and comments from stakeholders, EPA has made changes to GEM. The current version of GEM is v2.0.1, which is the version applicable for the Phase 1 standards.[83]

(2) Phase 1 Engine Standards and Engine Test Procedure

For Phase 1 the agencies set separate engine fuel consumption and CO_2 standards for engines installed in tractors and vocational vehicle chassis. EPA also set separate engine cap standards for methane (CH_4) and nitrous oxide (N_2O) emissions. These Phase 1 engine standards are specified in terms of brake-specific (g/hp-hr) fuel, CO_2, CH_4 and N_2O emissions limits. For these separate engine standards, the agencies adopted an engine dynamometer test procedure, which was built substantially from EPA's existing heavy-duty engine emissions test procedure. Since the test procedure already specified how to measure fuel consumption, CO_2 and CH_4, few changes were needed to employ the test procedure for purposes of the Phase 1 standards. For Phase 1 the test procedure was modified to specify how to measure N_2O.

The duty cycles from EPA's existing heavy-duty emissions test procedure were used in a somewhat unique way for Phase 1. In EPA's non-GHG engine emissions standards, heavy-duty engines must meet brake-specific standards for emissions of total oxides of nitrogen (NO_X), particulate mass (PM), non-methane hydrocarbon (NMHC), and carbon monoxide (CO). These standards must be met by all engines both over a 13-mode steady-state duty cycle called the ''Supplemental Emissions Test'' (SET) and over a composite of a cold-start and a hot-start transient duty cycle called the ''Federal Test Procedure'' (FTP). In contrast, for Phase 1 the agencies require that engines specifically installed in tractors meet fuel efficiency and CO_2 standards over only the SET but not the FTP. This requirement was intended to reflect that tractor engines typically operate near steady-state conditions versus transient conditions. See 76 FR 57159. The agencies adopted the converse for engines installed in vocational vehicles. That is, these engines must meet fuel efficiency and CO_2 standards over only the hot-start FTP but not the SET. This requirement was intended to reflect that vocational vehicle engines typically operate under transient conditions versus steady-state conditions (76 FR 57178). For both tractor and vocational vehicle engines in Phase 1, EPA set CH_4 and N_2O emissions cap standards over the cold-start and hot-start FTP only and not over the SET duty cycle. See Section II. D. for details on how we propose to modify the engine test procedure for Phase 2.

B. Phase 2 Proposed Regulatory Structure

For Phase 2, the agencies are proposing to modify the regulatory structure used for Phase 1. Note that we are not proposing to apply the new Phase 2 regulatory structure for compliance with the Phase 1 standards. The structure used to demonstrate compliance with the Phase 1 standards will remain as finalized in the Phase 1 regulation. The modifications we are proposing are consistent with the agencies' Phase 1 commitments to consider a range of regulatory approaches during the development of

[81] See 76 FR 57146–57147.

[82] U.S. Environmental Protection Agency. ''Peer Review of the Greenhouse Gas Emissions Model (GEM) and EPA's Response to Comments.'' EPA–420–R–11–007. Last access on November 24, 2014 at *http://www.epa.gov/otaq/climate/documents/420r11007.pdf*.

[83] See EPA's Web site at *http://www.epa.gov/otaq/climate/gem.htm* for the Phase 1 GEM revision dated May 2013, made to accommodate a revision to 49 CFR 535.6(b)(3).

future regulatory efforts (76 FR 57133), especially for vehicles not already subject to full vehicle chassis dynamometer testing. For example, we committed to consider a more sophisticated approach to vehicle testing to more completely capture the complex interactions within the total vehicle, including the engine and powertrain performance. We also intended to consider the potential for full vehicle certification of complete tractors and vocational chassis using a chassis dynamometer test procedure. We also considered chassis dynamometer testing of complete tractors and vocational chassis as a complementary approach for validating a more complex vehicle simulation approach. We also committed to consider the potential for a regulatory program for some of the trailers hauled by tractors. After considering these various approaches, the agencies are proposing a structure in which regulated tractor and vocational chassis manufacturers would additionally enter engine and powertrain-related inputs into GEM, which was not allowed in Phase 1.

For trailer manufacturers, which would be subject to first-time standards under the proposal, we are also proposing GEM-based certification. However, we are proposing a simplified structure that would allow certification without the manufacturers actually running GEM. More specifically, the agencies have developed a simple equation that uses the same trailer inputs as GEM to represent the emission impacts of aerodynamic improvements, tire improvements, and weight reduction. As described in Chapter 2.10.6 of the draft RIA, these equations have nearly perfect correlation with GEM so that they can be used instead of GEM without impacting stringency.

We are proposing both required and optional test procedures to provide these additional GEM inputs. We are also proposing to significantly expand the number of technologies recognized in GEM. Further, we are proposing to modify the GEM duty cycles and to further subdivide the vocational vehicle subcategory to better represent real-world vehicle operation. In contrast to these changes, we are proposing to maintain essentially the same chassis dynamometer test procedure for certifying complete heavy-duty pickups and vans.

(1) Other Structures Considered

To follow-up on the commitment to consider other approaches, the agencies spent significant time and resources in evaluating six different options for demonstrating compliance with the proposed Phase 2 standards. These six options include full vehicle chassis dynamometer testing, full vehicle simulation, and vehicle simulation in combination with powertrain testing, engine testing, engine electronic controller and/or transmission electronic controller testing. The agencies evaluated these options in terms of the capital investment required of regulated manufacturers to conduct the testing and/or simulation, the cost per test, the accuracy of the simulation, and the challenges of validating the results. Other considerations included the representativeness to the real world behavior, maintaining existing Phase 1 certification approaches that are known to work well, enhancing the Phase 1 approaches that could use improvements, the alignment of test procedures for determining GHG and non-GHG emissions compliance, and the potential to circumvent the intent of the test procedures.

Chassis dynamometer testing is used extensively in the development and certification of light-duty vehicles. It also is used in Phase 1 for complete Class 2b/3 pickups and vans, as well as for certain incomplete vehicles (at the manufacturer's option). The agencies considered chassis dynamometer testing more broadly as a heavy-duty fuel efficiency and GHG certification option because chassis dynamometer testing has the ability to evaluate a vehicle's performance in a manner that most closely resembles the vehicle's in-use performance. Nearly all of the fuel efficiency technologies can be evaluated on a chassis dynamometer, including the vehicle systems' interactions that depend on the behavior of the engine, transmission, and other vehicle electronic controllers. One challenge associated with application of wide-spread heavy-duty chassis testing is the small number of heavy-duty chassis test sites that are available in North America. As discussed in draft RIA Chapter 3, the agencies were only able to locate 11 heavy-duty chassis test sites. However, we have seen an increased interest in building new sites since issuing the Phase 1 Final Rule. For example, EPA is currently building a heavy-duty chassis dynamometer with the ability to test up to 80,000 pound vehicles at the National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Michigan.

Nevertheless, the agencies continue to be concerned about proposing a chassis test procedure for certifying tractors or vocational chassis due to the initial cost of a new test facility and the large number of heavy duty tractor and vocational chassis variants that could require testing. We have also concluded that for heavy-duty tractors and vocational chassis, there can be increased test-to-test variability under chassis dynamometer test conditions. First, the agencies recognize that such testing requires expensive, specialized equipment that is not widely available. The agencies estimate that it would vary from about $1.3 to $4.0 million per new test site depending on existing facilities.[84] In addition, the large number of heavy-duty vehicle configurations would require significant amounts of testing to cover the sector. For example, for Phase 1 tractor manufacturers typically certified several thousand variants of one single tractor model. Finally, EPA's evaluation of heavy-duty chassis dynamometer testing has shown that the variation of chassis test results is greater than light-duty testing, up to 3 percent worse, based on our sponsored testing at Southwest Research Institute.[85] Although the agencies are not proposing chassis dynamometer certification of tractors and vocational chassis, we believe such an approach could be appropriate in the future for some heavy duty vehicles if more test facilities become available and if the agencies are able to address the large number of vehicle variants that might require testing. We request comment on whether or not a chassis dynamometer test procedure should be required in lieu of the vehicle simulation approach we are proposing. Note, as discussed in Section II. C. (4) (b) that we are also proposing a modest complete tractor heavy-duty chassis dynamometer test program only for monitoring complete tractor fuel efficiency trends over the implementation timeframe of the Phase 1 and proposed Phase 2 standards.

Another option considered for certification involves testing a vehicle's powertrain in a modified engine dynamometer test facility. In this case the engine and transmission are installed in a laboratory test facility and a dynamometer is connected to the output shaft of the transmission. GEM or an equivalent vehicle simulation computer program is then used to control the dynamometer to simulate vehicle speeds and loads. The step-by-step test procedure considered for this option was initially developed as an option for hybrid powertrain testing for Phase 1. A key advantage of the powertrain test approach is that it

[84] 03–19034 TASK 2 Report-Paper 03-Class8_hil_DRAFT, September 30, 2013.

[85] GEM Validation, Technical Research Workshop, San Antonio, December 10–11, 2014.

directly measures the effectiveness of the engine, the transmission, and the integration of the two. Engines and transmissions are particularly challenging to simulate within a computer program like GEM because engines and transmissions installed in vehicles today are actively and interactively controlled by their own sophisticated electronic controls. These controls already contain essentially their own vehicle simulation programs that GEM would then have to otherwise simulate.

We believe that the capital investment impact for powertrain testing on manufacturers could be manageable for those that already have heavy-duty engine dynamometer test cells. We have found that in general medium-duty powertrains can be tested in heavy-duty engine test cells. EPA has successfully completed such a test facility conversion at the National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Michigan. Southwest Research Institute (SwRI) in San Antonio, Texas has completed a similar test cell conversion. Oak Ridge National Laboratory in Oak Ridge, Tennessee recently completed construction of a new and specialized heavy heavy-duty powertrain dynamometer facility. EPA also contracted SwRI to evaluate North America's current capabilities for powertrain testing in the heavy-duty sector and the cost of installing a new powertrain cell that would meet agency requirements.[86] Results indicated that one supplier currently has this capability. We estimate that the upgrade costs to an existing engine test facility are on the order of $1.2 million, and a new test facility in an existing building are on the order of $1.9 million. We also estimate that current powertrain test cells that could be upgraded to measure CO_2 emissions would cost approximately $600,000. For manufacturers or suppliers wishing to contract out such testing, SwRI estimated that a cost of $150,000 would provide about one month of powertrain testing services. Once a powertrain test cell is fully operational, we estimate that for a nominal powertrain family (*i.e.* one engine family tested with one transmission family), the cost for powertrain installation, testing, and data analysis would be $68,972.

Since the Phase 1 Final Rule, the agencies and other stakeholders have completed significant new work toward refining the powertrain test procedure itself. The proposed regulations provide details of the refined powertrain test procedure. See 40 CFR 1037.550.

Furthermore, the agencies have worked with key transmission suppliers to develop an approach to define transmission families. Coupled with the agencies existing definitions of engine families (40 CFR 1036.230 and 1037.230), we are proposing an approach to define a powertrain family in 40 CFR 1037.231. We request comment on what key attributes should be considered when defining a transmission family.

We believe that a combination of a robust powertrain family definition, a refined powertrain test procedure and a refined GEM could become an optimal certification path that leverages the accuracy of powertrain testing along with the versatility of GEM, which alleviates the need to test a large number of vehicle or powertrain variants. To balance the potential advantages of this approach with the fact that it has never been used for vehicle certification in the past, we are proposing to allow this approach as an optional certification path, as described in Section II.B.(2)(b). To be clear, we are not proposing to require powertrain testing at this time, but because this testing would recognize additional technologies that are not recognized directly in GEM (even as proposed to be amended), we are factoring its use into our stringency considerations for vocational chassis. We request comment on whether the agencies should consider requiring powertrain testing more broadly.

Another regulatory structure option considered was engine-only testing over the GEM duty cycles over a range of simulated vehicle configurations. This approach would use GEM to generate engine duty cycles by simulating a range of transmissions and other vehicle variations. These engine duty cycles then would be programmed into a separate controller of a dynamometer connected to an engine's output shaft. Unlike the chassis dynamometer or powertrain dynamometer approaches, which could have significant test facility construction or modification costs, this approach has little capital investment impact on manufacturers because the majority already have engine test facilities to both develop engines and to certify engines to meet both the non-GHG standards and the Phase 1 fuel efficiency and GHG standards. The agencies also have been investigating this approach as an alternative way to generate data that could be used to represent an engine in GEM. Because this approach captures engine performance under transient conditions, this approach could be an improvement over our proposed Phase 2 approach of representing an engine in GEM with only steady-state operating data. Details of this alternative are described in draft RIA. Because this approach is new and has never been used for vehicle development or certification, we are not proposing requiring its use as part of the Phase 2 certification process. However, we encourage others to investigate this new approach in detail, and we request comment on whether or not the agencies should replace our proposed steady-state operation representation of the engine in GEM with this alternative approach.

Additional certification options considered included simulating the engine, transmission, and vehicle using a computer program while having the actual transmission electronic controller connected to the computer running the vehicle simulation program. The output of the simulation would be an engine cycle that would be used to test the engine in an engine test facility. Just as in the engine-only test procedure, this procedure would not require significant capital investment in new test facilities. An additional benefit of this approach would be that the actual transmission controller would be determining the transmission gear shift points during the test, without a transmission manufacturer having to reveal their proprietary transmission control logic. This approach comes with some technical challenges, however. The model would have to become more complex and tailored to each transmission and controller to make sure that the controller would operate properly when it is connected to a computer instead of a transmission. Some examples of the transmission specific requirements would be simulating all the Controller Area Network (CAN) communication to and from the transmission controller and the specific sensor responses both through simulation and hardware. The vehicle manufacturer would have to be responsible for connecting the transmission controller to the computer, which would require a detailed verification process to ensure it is operating properly. Determining full compliance with this test procedure would be a significant challenge for the regulatory agencies because the agencies would have to be able to replicate each of the manufacturer's unique interfaces between the transmission controller and computer running GEM.

Finally, the agencies considered full vehicle simulation plus separate engine standards, which is the proposed

[86] 03–19034 TASK 2 Report-Paper 03-Class8_hil_DRAFT, September 30, 2013.

approach for Phase 2. These are discussed in more detail in the following sections.

(2) Proposed Regulatory Structure

Under the proposed structure, tractor and vocational chassis manufacturers would be required to provide engine, transmission, drive axle(s) and tire radius inputs into GEM. For Phase 1, GEM used default values for all of these, which limited the types of technologies that could be recognized by GEM to show compliance with the standards. We are proposing to significantly expand GEM to account for a wider range of technological improvements that would otherwise need to be recognized through some off-cycle crediting approach. These include improvements to the driver controller (*i.e.,* the simulation of the driver), engines, transmissions, and axles. Additional technologies that would now be recognized in GEM also include lightweight thermoplastic materials, automatic tire inflation systems, advanced cruise control systems, engine stop-start idle reduction systems, and axle configurations that decrease the number of drive axles. The agencies are also proposing to maintain separate engine standards. As described below, we see advantages to having both engine-based and vehicle-based standards. Moreover, the advantages described here for full vehicle simulation do not necessarily correspond to disadvantages for engine testing or vice versa.

(a) Advantages of Full Vehicle Simulation

The agencies' primary purpose in developing fuel efficiency and GHG emissions standards is to increase the use of vehicle technologies that improve fuel efficiency and decrease GHG emissions. Under the Phase 1 tractor and vocational chassis standards, there is no regulatory incentive for manufacturers to adopt new engine, transmission or axle technologies because GEM was not configured to recognize these technologies uniquely. By recognizing such technologies in GEM under Phase 2, the agencies would be creating a regulatory incentive to improve engine, transmission, and axle technologies to improve fuel efficiency and decrease GHG emissions. In its 2014 report, NAS also recognized the benefits of full vehicle simulation and recommended that Phase 2 incorporate such an approach.

We anticipate that the proposed Phase 2 approach would create three new specific regulatory incentives. First, vehicle manufacturers would have an incentive to use the most efficient engines. Since GEM would no longer use the agency default engine in simulation manufacturers would have their own more efficient engines recognized in GEM. Under Phase 1, engine manufacturers have a regulatory incentive to design efficient engines, but vehicle manufacturers do not have a similar regulatory incentive to use efficient engines in their vehicles. Second, the proposed approach would create incentives for both engine and vehicle manufacturers to design engines and vehicles to work together to ensure that engines actually operate as much as possible near their most efficient points. This is because Phase 2 GEM would allow the vehicle manufactures to use specific transmission, axle, and tire characteristics as inputs, thus having the ability to directly recognize many powertrain integration benefits, such as downspeeding, and different transmission architectures and technologies, such as automated manual transmissions, automatic transmissions,, and different numbers of transmission gears, transmission gear ratios, axle ratios and tire revolutions per mile. No matter how well designed, all engines have speed and load operation points with differing fuel efficiency and GHG emissions. The speed and load point with the best fuel efficiency (*i.e.,* peak thermal efficiency) is commonly known as the engine's ''sweet spot''. The more frequently an engine operates near its sweet spot, the better the vehicle's fuel efficiency will be. In Phase 1, a vehicle manufacturer receives no regulatory credit for designing its vehicle to operate closer to the sweet spot because Phase 1 GEM does not model the actual engine, transmission, axle, or tire revolutions per mile. Third, the proposed approach would recognize improvements to the overall efficiency of the drivetrain including the axle. The proposed version of GEM would recognize the benefits of different axle technologies including axle lubricants, and reducing axle losses such as by enabling three-axle vehicles to deliver power to only one rear axle through the proposed post-simulation adjustment approach (see Chapter 4.5 of the Draft RIA).

In addition to providing regulatory incentives to use more fuel efficient technologies, expanding GEM to recognize engine and other powertrain component improvements would also provide important flexibility to vehicle manufacturers. The flexibility to effectively trade engine and other component improvements against other vehicle improvements would allow vehicle manufacturers to better optimize their vehicles to achieve the lowest cost for specific customers. Vehicle manufacturers could use this flexibility to reduce overall compliance costs and/ or address special applications where certain vehicle technologies are not practical. The agencies considered in Phase 1 allowing the exchange of emission certification credits generated relative to the separate brake-specific (g/ hp-hr) engine standards and credits generated relative to the vehicle standards (g/ton-mile). However, we did not allow this in Phase 1 due in part to concerns about the equivalency of credits generated relative to different standards, with different units of measure and different test procedures. The proposed approach for Phase 2 would eliminate these concerns because engine and other vehicle component improvements would be evaluated relative to the same vehicle standard in GEM. This also means that under the proposed Phase 2 approach there is no need to consider allowing emissions credit trading between engine-generated and vehicle-generated credits because vehicle manufacturers are directly credited by the combination of engine and vehicle technologies they choose to install in each vehicle. Therefore, this approach eliminates one of the concerns about continuing separate engine standards, which was that a separate engine standard and a full vehicle standard were somehow mutually exclusive. That is not the case. In fact, in the next section we describe how we propose to continue the separate engine standard along with recognizing engine performance at the vehicle level. The agencies acknowledge that maintaining a separate engine standard would limit flexibility in cases where a vehicle manufacturer wanted to use less efficient engines and make up for them using more efficient vehicle technologies. However, as described below, we see important advantages to maintaining a separate engine standard, and we believe they more than justify the reduced flexibility.

There could be disadvantages to the proposed approach, however. As is discussed in Section II.B.(2)(b), some of the disadvantages can be addressed by maintaining separate engine standards, which we are proposing to do. We request comment on other disadvantages such as those discussed below.

One disadvantage of the proposed approach is that it would increase complexity for the vehicle standards. For example, vehicle manufacturers would be required to conduct additional engine tests and track additional GEM inputs for compliance purposes. However, we believe that most of the burden associated with this increased complexity would be an infrequent burden of engine testing and updating information systems to track these inputs.

Because GEM measures performance over specific duty cycles intended to represent average operation of vehicles in-use, the proposed approach might also create an incentive to optimize powertrains and drivetrains for the best GEM performance rather than the best in-use performance for a particular application. This is always a concern when selecting duty cycles for certification. There will always be instances, however infrequent, where specific vehicle applications will operate differently than the duty cycles used for certification. The question is would these differences force manufacturers to optimize vehicles to the certification duty cycles in a way that decreases fuel efficiency and increases GHG emissions in-use? We believe that the certification duty cycles would not prevent manufacturers from properly optimizing vehicles for customer fuel efficiency. First, the impact of the certification duty cycles would be relatively small because they affect only a small fraction of all vehicle technologies. Second, the emission averaging and fleet average provisions mean that the proposed regulations would not require all vehicles to meet the standards. Vehicles exceeding a standard over the duty cycles because they are optimized for different in-use operation can be offset by other vehicles that perform better over the certification duty cycles. Third, vehicle manufacturers would also have the ability to lower such a vehicle's measured GHG emissions by adding technology that would improve fuel efficiency both over the certification duty cycles and in-use. The proposed standards are not intended to be at a stringency where manufacturers would be expected to apply all technologies to all vehicles. Thus, there should be technologies available to add to vehicle configurations that initially fail to meet the Phase 2 proposed standards. Fourth, we are proposing further sub-categorization of the vocational vehicle segment, tripling the number of subcategories within this segment from 3 to 9. These 9 subcategories would divide each of the 3 Phase 1 weight categories into 3 additional vehicle speed categories. Each of the 3 speed categories would have unique duty cycle weighting factors to recognize that different vocational chassis are configured for different vehicle speed applications. Furthermore, we are proposing 9 unique standards for each of the subcategories. This further subdivision better recognizes technologies' performance under the conditions for which the vocational chassis was configured to operate. This further decreases the potential of the certification duty cycles to encourage manufacturers to configure vocational chassis differently than the optimum configuration for specific customers' applications. Finally, as required by Section 202 (a) (1) and 202 (d) of the CAA, EPA is proposing specific GHG standards which would have to be met in-use.

One disadvantage of our proposed full vehicle simulation approach is the potential requirement for engine manufacturers to disclose otherwise proprietary information to vehicle manufacturers who install their engines. Under the proposed approach, vehicle manufacturers would need to know details about engine performance long before production, both for compliance planning purposes, as well as for the actual submission of applications for certification. Moreover, vehicle manufacturers would need to know details about the engine's performance that are generally not publicly available—specifically the detailed fuel consumption of an engine over many steady-state operating points. We request comment on whether or not such information could be used to ''reverse engineer'' intellectual property related to the proprietary design of engines, and what steps the agencies could take to address this.

The agencies also generally request comment on the advantages and disadvantages of the proposed structure that would require vehicle manufacturers to provide additional inputs into GEM to represent the engine, transmission, drive axle(s), and loaded tire radius.

(b) Advantages of Separate Engine Standards

For engines installed in tractors and vocational vehicle chassis, we are proposing to maintain separate engine standards for fuel consumption and GHG emissions in Phase 2 for both SI and CI engines. Moreover, we are proposing new more stringent engine standards for CI engines. While the vehicle standards alone are intended to provide sufficient incentive for improvements in engine efficiency, we continue to see important advantages to maintaining separate engine standards for both SI and CI engines. The agencies believe the advantages described below are critical to fully achieve the goals of the NHTSA and EPA standards.

First, EPA has a robust compliance program based on engine testing. For the Phase 1 standards, we applied the existing criteria pollutant compliance program to ensure that engine efficiency in actual use reflected the improvements manufacturers claimed during certification. With engine-based standards, it is straightforward to hold engine manufacturers accountable by testing in-use engines. If the engines exceed the standards, they can be required to correct the problem or perform other remedial actions. Without separate engine standards in Phase 2, addressing in-use compliance becomes more subjective. Having clearly defined compliance responsibilities is important to both the agencies and to the market.

Second, engine standards for CO_2 and fuel efficiency force engine manufacturers to optimize engines for both fuel efficiency and control of non-CO_2 emissions at the same engine operating points. This is of special concern for NO_X emissions, given the strong counter-dependency between engine-out NO_X emissions and fuel consumption. By requiring engine manufacturers to comply with both NO_X and CO_2 standards using the same test procedures, the agencies ensure that manufacturers include technologies that can be optimized for both rather than alternate calibrations that would trade NO_X emissions against fuel consumption depending how the engine or vehicle is tested. In the past, when there was no CO_2 engine standard and no steady-state NO_X standard, some manufacturers chose this dual calibration approach instead of investing in technology that would allow them to simultaneously reduce both CO_2 and NO_X.

Third, engine fuel consumption can vary significantly between transient operation and steady-state operation, and we are proposing only steady-state engine operating data as the required engine input into GEM for both tractor and vocational chassis certification. Because vocational vehicles can spend significant operation under transient engine operation, the separate engine standard for engines installed in vocational vehicles is a transient test. Therefore, the separate engine standard for vocational engines provides the only measure of engine fuel consumption and CO_2 emissions under transient conditions. Without a transient engine test we would not be able to ensure control of fuel consumption and CO_2 emissions under transient engine conditions.

It is worth noting that these first three advantages are also beneficial for the marketplace. In these respects, the separate engine standards allow each manufacturer to be confident that its competitors are playing by the same rules. The agencies believe that the absence of a separate engine standard would leave open the possibility that a manufacturer might choose to cut corners with respect to in-use compliance margins, the NO_X-CO_2 tradeoff, or transient controls. Concerns that competitors might take advantage of this can put a manufacturer in a difficult situation. On the other hand knowing that the agencies are ensuring all manufacturers are complying fully can eliminate these concerns.

Finally, the existence of meaningful separate engine standards allows the agencies to exempt certain vehicles from some or all of the vehicle standards and requirements without forgoing the engine improvements. A good example of this is the off-road vehicle exemption in 40 CFR 1037.631 and 49 CFR 535.3, which exempts vehicles ''intended to be used extensively in off-road environments'' from the vehicle requirements. The engines used in such vehicles must still meet the engine standards of 40 CFR 1036.108 and 49 CFR 535.5(d). The agencies see no reason why efficient engines cannot be used in such vehicles. However, without separate engine standards, there would be no way to require them to be efficient.

In the past there has been some confusion about the Phase 1 separate engine standards somehow preventing the recognition of engine-vehicle optimization that vehicle manufacturers perform to minimize a vehicle's overall fuel consumption. It was not the existence of separate engine standards that prevented recognition of this optimization. Rather it was that the agencies did not allow manufacturers to enter inputs into GEM that characterized unique engine performance. For Phase 2 we are proposing to require that manufacturers input such data because we intend for GEM to recognize this engine-vehicle optimization. The continuation of separate engine standards in Phase 2 does not undermine in any way the recognition of this optimization in GEM.

The agencies request comment on the advantages and disadvantages of the proposal to maintain separate engine standards and to increase the stringency of the CI engine standards. We would also welcome suggested alternative approaches that would achieve the same goals. It is important to emphasize that the agencies see the advantages of separate engine standards as fundamental to the success of the program and do not expect to adopt alternative approaches that fall short of these goals.

Note that commenters opposing separate engine standards should also be careful distinguish between concerns related to the stringency of the proposed engine standards, from concerns inherent to any separate engine standards whatsoever. When meeting with manufacturers prior to this proposal, the agencies heard many concerns about the potential problems with separate engines standards that were actually concerns about separate engine standards that are too stringent. However, we see these as two different issues. The agencies do recognize that setting engine standards at a high stringency could increase the cost to comply with the vehicle standard, if lower-cost vehicle technologies are available. Additionally, the agencies recognize that setting engine standards at a high stringency may promote the use of large-displacement engines, which have inherent heat transfer and efficiency advantages over smaller displacement engines over the engine test cycles, though a smaller engine may be more efficient for a given vehicle application. Thus we encourage commenters supporting the separate engine standards to address the possibility of unintended consequences such as these.

C. Proposed Vehicle Simulation Model—Phase 2 GEM[87]

For tractors and vocational vehicle chassis, the agencies propose that manufacturers would be required to meet vehicle-based standards, and certification to these standards would be facilitated by the required use of the vehicle simulation computer program called, ''Greenhouse gas Emissions Model'' or ''GEM.'' GEM was created for Phase 1 for the exclusive purpose of certifying tractors and vocational chassis. The agencies are proposing to modify GEM and to require vehicle manufacturers to provide additional inputs into GEM to represent the engine, transmission, drive axle(s), and loaded tire radius. For Phase 1, GEM used agency default values for all of these parameters. Under the proposed approach for Phase 2, vehicle manufacturers would be able to use these technologies, plus additional technologies to demonstrate compliance with the applicable standards. The additional technologies include lightweight thermoplastic materials, automatic tire inflation systems, advanced cruise control systems, engine stop-start idle reduction systems, and axle configurations that decrease the number of drive axles to comply with the standards.

(1) Description of the Proposed Modifications to GEM

As explained above, GEM is a computer program that was originally developed by EPA specifically for manufacturers to use to certify to the Phase 1 tractor and vocational chassis standards. GEM mathematically combines the results of vehicle component test procedures with other vehicle attributes to determine a vehicle's certified levels of fuel consumption and CO_2 emissions. For Phase 1 the required inputs to GEM include vehicle aerodynamics information, tire rolling resistance, and whether or not a vehicle is equipped with certain lightweight high-strength steel or aluminum components, a tamper-proof speed limiter, or tamper-proof idle reduction technologies for tractors. The vocational vehicle inputs to GEM for Phase 1 only included tire rolling resistance. For Phase 1 the GEM's inputs did not include engine test results or attributes related to a vehicle's powertrain; namely, its transmission, drive axle(s), or loaded tire radius. Instead, for Phase 1 the agencies specified a generic engine and powertrain within GEM, and for Phase 1 these cannot be changed in GEM.

For this proposal GEM has been modified and validated against a set of experimental data that represents over 130 unique vehicle variants. EPA believes this new version of GEM is an accurate and cost-effective alternative to measuring fuel consumption and CO_2 over a chassis dynamometer test procedure. Some of the key proposed modifications would necessitate required and optional vehicle component test procedures to generate additional GEM inputs. The results of which would provide additional inputs into GEM. These include a new required engine test procedure to provide steady-state engine fuel consumption and CO_2 inputs into GEM. We are also seeking comment on a newly developed engine test procedure that also captures transient engine performance for use in GEM. We are proposing to require inputs that describe the vehicle's transmission type, and its number of gears and gear ratios. We are proposing an optional powertrain test procedure that would provide inputs to override

[87] The specific version of GEM used to develop the proposed standards, and which we propose to use for compliance purposes is also known as GEM 3.0.

the agencies' simulated engine and transmission in GEM. We are proposing to require inputs that describe the vehicle's drive axle(s) type (*e.g.,* 6x4 or 6x2) and axle ratio. We are also seeking comment on an optional axle efficiency test procedure to override the agencies' simulated axle in GEM. We are proposing to significantly expand the number of technologies that are recognized in GEM. These include recognizing lightweight thermoplastic materials, automatic tire inflation systems, advanced cruise control systems, engine stop-start idle reduction systems, and axle configurations that decrease the number of drive axles. We are seeking comment on recognizing (outside of the GEM simulation) additional technologies such as high efficiency glass and low global warming potential air conditioning refrigerants. To better reflect real-world operation, we are also proposing to revise the vehicle simulation computer program's urban and rural highway duty cycles to include changes in road grade. We are seeking comment on whether or not these duty cycles should also simulate driver behavior in response to varying traffic patterns. We are proposing a new duty cycle to capture the performance of technologies that reduce the amount of time a vehicle's engine is at idle during a workday when the vehicle is not moving. And to better recognize that vocational vehicle powertrains are configured for particular applications, we are proposing to further subdivide the vocational chassis category into three different vehicle speed categories, where GEM weights the individual duty cycles' results of each of the speed categories differently. Section 4.2 of the RIA details all these modifications. This section briefly describes some of the key proposed modifications to GEM.

(a) Simulating Engines for Vehicle Certification

Before describing the proposed approach for Phase 2, this section first reviews how engines are simulated for vehicle certification in Phase 1. GEM for Phase 1 simulates the same generic engine for any vehicle in a given regulatory subcategory with a data table of steady-state engine fuel consumption mass rates (g/s) versus a series of steady-state engine output shaft speeds (revolutions per minute, rpm) and loads (torque, N-m). This data table is also sometimes called a ''fuel map'' or an ''engine map'', although the term ''engine map'' can mean other kinds of data in different contexts. The engine speeds in this map range from idle to maximum governed speed and the loads range from engine motoring (negative load) to the maximum load of an engine. When GEM runs over a vehicle duty cycle, this data table is linearly interpolated to find a corresponding fuel consumption mass rate at each engine speed and load that is demanded by the simulated vehicle operating over the duty cycle. The fuel consumption mass rate of the engine is then integrated over each duty cycle in GEM to arrive at the total mass of fuel consumed for the specific vehicle and duty cycle. Under Phase 1, manufacturers were not allowed to input their own engine fuel maps to represent their specific engines in the vehicle being simulated in GEM. Because GEM was programmed with fixed engine fuel maps for Phase 1 that all manufacturers had to use, interpolation of the tables themselves over each of the three different GEM duty cycles did not have to closely represent how an actual engine might operate over these three different duty cycles.

In contrast, for Phase 2 we are proposing a new and required steady-state engine dynamometer test procedure for manufacturers to use to generate their own engine fuel maps to represent each of their engine families in GEM. The proposed Phase 2 approach is consistent with the 2014 NAS Phase 2 First Report recommendation.[88] To validate this approach we compared the results from 28 individual engine dynamometer tests. Three different engines were used to generate this data, and these engines were produced by two different engine manufacturers. One engine was tested at three different power ratings (13 liters at 410, 450 & 475 hp) and one engine was tested at two ratings (6.7 liters at 240 and 300 hp), and other engine with one rating (15 liters 455 hp) service classes. For each engine and rating our proposed steady-state engine dynamometer test procedure was conducted to generate an engine fuel map to represent that particular engine in GEM. Next, with GEM we simulated various vehicles in which the engine could be installed. For each of the GEM duty cycles we are proposing, namely the urban local (ARB Transient), urban highway with road grade (55 mph), and rural highway with road grade (65 mph) duty cycles, we determined the GEM result for each vehicle configuration, and we saved the engine output shaft speed and torque information that GEM created to interpolate the steady-state engine map for each vehicle configuration. We then had this same engine output shaft speed and torque information programmed into an engine dynamometer controller, and we had each engine perform the same duty cycles that GEM demanded of the simulated version of the engine. We then compared the GEM results based on GEM's linear interpolation of the engine maps to the measured engine dynamometer results. We concluded that for the 55 mph and 65 mph duty cycles, GEM's interpolation of the steady-state data tables was sufficiently accurate versus the measured results. This is an outcome one would reasonably expect because even with changes in road grade, the 55 mph and 65 mph duty cycles do not demand rapid changes in engine speed or load. The 55 mph and 65 mph duty cycles are nearly steady-state, as far as engine operation is concerned, just like the engine maps themselves. However, for the ARB Transient cycle, we observed a consistent bias, where GEM consistently under-predicted fuel consumption and CO_2 emissions. This low bias over the 28 engine tests ranged from 4.2 percent low to 7.8 percent low. The mean was 5.9 percent low and the 90th percentile value was 7.1 percent low. These observations are consistent with the fact that engines generally operate less efficiently under transient conditions than under steady-state conditions.

A number of reasons explain this consistent trend. For example, under rapidly changing engine conditions, it is generally more challenging to program an engine electronic controller to respond with optimum fuel injection rate and timing, exhaust gas recirculation valve position, variable nozzle turbo-charger vane position and other set points than it is to do so under steady-state conditions. Transient heat and mass transfer within the intake, exhaust, and combustion chambers also tend to increase turbulence and enhance energy loss to engine coolant during transient operation. Furthermore, because exhaust emissions control is more challenging under transient engine operation, engineering tradeoffs sometimes need to be made between fuel efficiency and transient emissions control. Special calibrations are typically also required to control smoke and manage exhaust temperatures during transient operation for a transient cycle. We are confident that this low bias in GEM would continue to exist well into the future if we were to test additional engines. However, with the range of the results that we have generated so far we are somewhat less confident in proposing a single numerical value to correct for this effect

[88] National Academy of Science. ''Reducing the Fuel Consumption and GHG Emissions of Medium- and Heavy-Duty Vehicles, Phase Two, First Report.'' 2014. Recommendation 3.8.

over the ARB Transient duty cycle. Based on the data we have collected so far, we are conservatively proposing to apply a 5.0 percent correction factor to GEM's ARB Transient results. Note that adjustment would be applied internal to GEM, and no manufacturer input or action would be needed. This means that for GEM fuel consumption and CO_2 emissions results that were generated using the steady-state engine map representation of an engine in GEM, a 1.05 multiplier would be applied to only the ARB Transient result. If a manufacturer chooses to perform the optional powertrain test procedure we are proposing, then this 1.05 multiplier to the ARB Transient would not apply (since we know of no bias in that optional powertrain test). For the same reason, if we were to replace the proposed steady-state engine map in GEM with the alternative approach detailed in draft RIA, then this 1.05 multiplier would not apply. We request comment on whether or not this single value multiplier is an appropriate way to correct between steady-state and transient engine fuel consumption and CO_2 emissions, specifically over the ARB Transient duty cycle. We also request comment on the magnitude of the multiplier itself. For example, for the proposal we have chosen a 1.05 multiplier correction value because it is conservative but still near the mean bias we observed. However, for the tests we have conducted on current technology engines, a 1.05 multiplier would mean that about one half of these engines would be penalized by powertrain testing (or if we utilized the alternative engine approach) because the actual measured transient impact would be slightly higher than 5 percent. While these tests were performed on current technology powertrains rather than the kind of optimized powertrains we project for Phase 2, these results raise still some concerns for us. Because we intend to incentivize powertrain testing and not penalize it, and because we also encourage constructive comments on the alternative approach, we also request comment on increasing the magnitude of this ARB Transient multiplier toward the higher end of the biases we observed. For example, we request comment on increasing the proposed multiplier from 1.05 to 1.07, which is close to the 90th percentile of the results we have collected so far. Using this higher multiplier would imply that only about 10 percent of engines powertrain tested or tested under the alternative approach would show worse fuel consumption over the ARB Transient than its respective representation in a steady-state data table in GEM. This would mean that the remaining 90 percent of engines powertrain tested would receive additional credit in GEM. Using 1.07 would essentially guarantee that any powertrain that was significantly more efficient than current powertrains would receive meaningful credit for the improvement. However, this value would also provide credits for many current powertrain designs.

We also request comment as to whether or not there might be certain vehicle sub-categories or certain small volume vocational chassis, where using the Phase 1 approach of using a generic engine table might be more appropriate. We also request comment as to whether or not the agencies should provide default generic engine maps in GEM for Phase 2 and allow manufacturers to optionally override these generic maps with their own maps, which would be generated according to our proposed engine dynamometer steady-state test procedure.

(b) Simulating Human Driver Behavior and Transmissions for Vehicle Certification

GEM for Phase 1 simulates the same generic human driver behavior and manual transmission for all vehicles. The simulated driver responds to changes in the target vehicle speed of the duty cycles by changing the simulated positions of the vehicle's accelerator pedal, brake pedal, clutch pedal, and gear shift lever. For simplicity in Phase 1 the GEM driver shifted at ideal points for maximum fuel efficiency and the manual transmission was simulated as an ideal transmission that did not have any delay time (*i.e.,* torque interruption) between gear shifts and did not have any energy losses associated with clutch slip during gear shifts.

In GEM for Phase 2 we are proposing to allow manufacturers to select one of three types of transmissions to represent the transmission in the vehicle they are certifying: manual transmission, automated manual transmission, and automatic transmission. We are currently in the process of developing a dual-clutch transmission type in GEM, but we are not proposing to allow its use in Phase 2 at this time. Because production of heavy-duty dual clutch transmissions has only begun in the past few months, we do not yet have any experimental data to validate our GEM simulation of this transmission type. Therefore, we are requesting comment on whether or not there is additional data available for such validation. Should such data be provided in comments, we may finalize GEM for Phase 2 with a fourth transmission types for dual clutch transmissions. We are also considering an option to address dual clutch transmissions through a post-simulation adjustment as discussed in Chapter 4 of the draft RIA.

In the proposed modifications to GEM, the driver behavior and the three different transmission types are simulated in the same basic manner as in Phase 1, but each transmission type features a unique combination of driver behavior and transmission responses that match both the driver behavior and the transmission responses we measured during vehicle testing of these three transmission types. In general the transmission gear shifting strategy for all of the transmissions is designed to shift the transmission so that it is always in the most efficient gear for the current vehicle demand, while staying within certain limits to prevent unrealistically high frequency shifting. Some examples of these limits are torque reserve limits (which vary as function of engine speed), minimum time-in-gear and minimum fuel efficiency benefit to shift to the next gear. Some of the differences between the three transmission types include a driver ''double-clutching'' during gear shifts of the manual transmission only, and ''power shifts'' and torque converter torque multiplication, slip, and lock-up in automatic transmissions only. Refer to Chapter 4 of the draft RIA for a more detailed description of these different simulated driver behaviors and transmission types.

We considered an alternative approach where transmission manufacturers would provide vehicle manufacturers with detailed information about their automated transmissions' proprietary shift strategies for representation in GEM. NAS also recommended this approach.[89] The advantages of this approach include a more realistic representation of a transmission in GEM and potentially the recognition of additional fuel efficiency improving strategies to achieve additional fuel consumption and CO_2 emissions reductions. However, there are a number of technical and policy disadvantages of this approach. One disadvantage is that it would require the

[89] Transportation Research Board 2014. ''Reducing the Fuel Consumption and Greenhouse Gas Emissions of Medium- and Heavy-Duty Vehicles, Phase Two.'' (''Phase 2 First Report'') Washington, DC, The National Academies Press. Cooperative Agreement DTNH22–12–00389. Available electronically from the National Academy Press Web site at *http://www.nap.edu/catalog.php?record_id=12845* (last accessed December 2, 2014). Recommendation 3.7.

disclosure of proprietary information between competing companies because some vehicle manufacturers produce their own transmissions and also use other suppliers' transmissions. There are technical challenges too. For example, some transmission manufacturers have upwards of 40 different shift strategies programmed into their transmission controllers. Depending on in-use driving conditions, some of which are not simulated in GEM (*e.g.,* changing payloads, changing tire traction) a transmission controller can change its shift strategy. Representing dynamic switching between multiple proprietary shift strategies would be extremely complex to simulate in GEM. Furthermore, if the agencies were to propose requiring transmission manufacturers to provide shift strategy inputs for use in GEM, then the agencies would have to devise a compliance strategy to monitor in-use shift strategies, including a driver behavior model that could be implemented as part of an in-use shift strategy test. This too would be very complex. If manufacturers were subject to in-use compliance requirements of their transmission shift strategies, this could lead to restricting the use of certain shift strategies in the heavy-duty sector, which would in turn potentially lead to sub-optimal vehicle configurations that do not improve fuel efficiency or adequately serve the wide range of customer needs; especially in the vocational vehicle segment. For example, if the agencies were to restrict the use of more aggressive and less fuel efficient in-use shift strategies that are used only under heavy loads and steep grades, then certain vehicle applications would need to compensate for this loss of capability through the installation of over-sized and over-powered engines that are subsequently poorly matched and less efficient under lighter load conditions. Therefore, as a policy consideration to preserve vehicle configuration choice and to preserve the full capability of heavy-duty vehicles today, the agencies are intentionally not requiring transmission manufacturers to submit detailed proprietary shift strategy information to vehicle manufacturers to input into GEM. This is not unlike Phase 1, where unique transmission and axle attributes were not recognized at all in GEM. Instead, the agencies are proposing that vehicle manufacturers choose from among the three transmission types that the agencies have already developed, validated, and programmed into GEM. The vehicle manufacturers would then enter into GEM their particular transmission's number of gears and gear ratios. The agencies recognize that designing GEM like this would exclude a potentially significant reduction from the GEM simulation. However, if a manufacturer chooses to use the optional powertrain test procedure, then the agencies' transmission types in GEM would be overridden by the actual data collected during the powertrain test, which would recognize the actual benefit of the transmission. Note that the optional powertrain test procedure is only advantageous to a vehicle manufacturer if an actual transmission is more efficient and has a superior shift strategy compared to its respective transmission type simulated in GEM.

(c) Simulating Axles for Vehicle Certification

In GEM for Phase 1 the axle ratio of the primary drive axle and the energy losses assumed in the simulated axle itself were the same for all vehicles. For Phase 2 we are proposing that the vehicle manufacturer input into GEM the axle ratio of the primary drive axle. This input would recognize the intent to operate the engine at a particular engine speed when the transmission is operating in its highest transmission gear; especially for the 55 mph and 65 mph duty cycles in GEM. This input facilitates GEM's recognition of vehicle designs that take advantage of operating the engine at the lowest possible engine speeds. This is commonly known as ''engine down-speeding'', and the general rule-of-thumb for heavy-duty engines is that for every 100 rpm decrease in engine speed, there can be about a 1 percent decrease in fuel consumption and CO_2 emissions. Therefore, it is important that GEM allow this value to be input by the vehicle manufacturer. Axle ratio is also straightforward to verify during any in-use compliance audit.

We are proposing a fixed axle ratio energy efficiency of 95.5 percent at all speeds and loads, but are requesting comment on whether this pre-specified efficiency is reasonable. However, we know that this efficiency actually varies as a function of axle speed and axle input torque. Therefore, as an exploratory test we have created a modified version of GEM that has as an input a data table of axle efficiency as a function of axle speed and axle torque. The modified version of GEM subsequently interpolates this table over each of the duty cycles to represent a more realistic axle efficiency at each point of each duty cycle. We have also created a draft axle ratio efficiency test procedure that requires the use of a dynamometer test facility. This procedure includes the use of a baseline fuel-efficient synthetic gear lubricant manufactured by BASF.[90] This baseline will be used to gauge improvements in axle design and lubricants. The draft test procedure includes initial feedback that we have received from axle manufacturers and our own engineering judgment. Refer to 40 CFR 1037.560 of the Phase 2 proposed regulations, which contain this draft test procedure. This test procedure could be used to generate the results needed to create the axle efficiency data table for input into GEM. However, the agencies have not yet conducted experimental tests of axles using this draft test procedure so we are reluctant to propose this test procedure as either mandatory or even optional at this time. Rather we request comment as to whether or not we should finalize this test procedure and either require its use or allow its use optionally to determine an axle efficiency data table as an input to GEM, which would override the fixed axle efficiency we are proposing at this time. We also request comment on improving or otherwise refining the test procedure itself. Note that the agencies believe that allowing the GEM default axle efficiency to be replaced by manufacturer inputs only makes sense if the manufacturer inputs is are the results of a specified test procedure that we could verify by our own independent testing of the axle.

In addition to proposing to require the primary drive axle ratio input into GEM (and potentially an option to input an actual axle efficiency data table), we are also proposing that the vehicle manufacturer input into GEM whether or not one or two drive axles are driven by the engine. When a heavy-duty vehicle is equipped with two rear axles where both are driven by the engine, this is called a ''6x4'' configuration. ''6'' refers to the total number of wheel hubs on the vehicle. In the 6x4 configuration there are two front wheel hubs for the two steer wheels and tires plus four rear wheel hubs for the four rear wheels and tires (or more commonly four *sets* of rear dual wheels and tires). ''4'' refers to the number of wheel hubs driven by the engine. These are the two rear axles that have two wheel hubs each. Compared to a 6x4 configuration a 6x2 configuration decreases axle energy loss due to friction and oil pumping in two driven axles, by driving only one axle. The decrease in fuel consumption and CO_2 emissions associated with a 6x2 versus 6x4 axle configuration is estimated to be

[90] BASF TI/EVO 0137 e, Emgard® FE 75W–90 Fuel Efficient Synthetic Gear Lubricant.

2.5 percent.[91] Therefore, in the proposed Phase 2 version of GEM, if a manufacturer simulates a 6x2 axle configuration, GEM decreases the overall GEM result by 2.5 percent. Note that GEM will similarly decrease the overall GEM result by 2.5 percent for a 4x2 tractor or Class 8 vocational chassis configuration if it has only two wheel hubs driven. Note that we are not proposing that GEM have an option to increase the overall GEM result by some percentage by selecting, say, a 6x6 or 8x8 option if the front axle(s) are driven. Because these configurations are only manufactured for specialized vehicles that require extra traction for off-road applications, they are very low volume sales and their increased fuel consumption and CO_2 emissions are not significant in comparison to the overall reductions of the proposed Phase 2 program. Note that 40 CFR 1037.631 (for off-road vocational vehicles), which is being continued from the Phase 1 program, would likely exempt many of these vehicles from the vehicle standards.

Instead of directly modeling 6x4 or 6x2 axle configuration, we are proposing use of a post-simulation adjustment approach discussed in Chapter 4 of the drat RIA to model benefits of different axle configuration.

(d) Simulating Accessories for Vehicle Certification

Phase 1 GEM uses a fixed power consumption value to simulate the fuel consumed for powering accessories such as power steering pumps and alternators. While the agencies are not proposing any changes to this approach for Phase 2, we are requesting comment on whether or not we should allow some manufacturer input to reflect the installation of accessory components that result in lower accessory loads. For example, we could consider an accessory load reduction GEM input based on installing a number of qualifying advanced accessory components that could be in production during Phase 2. We request comment on identifying such advanced accessory components, and we request comment on defining these components in such a way that they can be unambiguously distinguished from other similar components that do not decrease accessory loads. We also request comment on how much of a decrease in accessory load should be programmed into GEM if qualifying advanced accessory components are installed.

(e) Aerodynamics for Tractor, Vocational Vehicle, and Trailer Certification

For GEM in Phase 2 the agencies propose to simulate aerodynamic drag in largely the same manner as in Phase 1. For vocational chassis we propose to continue to use the same prescribed products of drag coefficient times vehicle frontal area (Cd*A) that were predefined for each of the vocational subcategories in Phase 1. For tractors we propose to continue to use an aerodynamic bin approach similar to the one that exists in Phase 1 today. This approach requires tractor manufacturers to conduct a certain amount of coast-down vehicle testing, although manufacturers have the option to conduct scaled wind tunnel testing and/or computational fluid dynamics modeling. The results of these tests determine into which bin a vehicle is assigned. Then in GEM the aerodynamic drag coefficient for each vehicle in the same bin is the same. This approach helps to account for limits in the repeatability of aerodynamic testing and it creates a compliance margin since any test result which keeps the vehicle in the same aerodynamic bin is considered compliant. However, for Phase 2 we are proposing new boundary values for the bins themselves and we are adding two additional bins in order to recognize further advances in aerodynamic drag reduction beyond what was recognized in Phase 1. Furthermore, while Phase 1 GEM used predefined frontal areas for tractors while the manufacturers input a Cd value, the agencies propose that manufacturers would use a measured drag area (CdA) value for each tractor configuration for Phase 2. See 40 CFR 1037.525.

In addition to these proposed changes we are proposing a number of aerodynamic drag test procedure improvements. One proposed improvement is to update the so-called standard trailer that is prescribed for use during aerodynamic drag testing of a tractor—that is, the hypothetical trailer modeled in GEM to represent a trailer paired with the tractor in actual use. In Phase 1 a non-aerodynamic 53-foot long box-shaped dry van trailer was specified as the standard trailer for tractor aerodynamic testing (see 40 CFR 1037.501(g)). For Phase 2 we are proposing to modify this standard trailer for tractor testing to make it more similar to the trailers we would require to be produced during the Phase 2 timeframe. More specifically, we would prescribe the installation of aerodynamic trailer skirts (and low rolling resistance tires as applied in Phase 1) on the reference trailer, as discussed in further in Section III.E.2. As explained more fully in Sections III and IV below, the agencies believe that tractor-trailer pairings will be optimized aerodynamically to a significant extent in-use (such as using high-roof cabs when pulling box trailers), and that this real-world optimization should be reflected in the certification testing. We also request comment on whether or not the Phase 2 standard trailer should include the installation of other aerodynamic devices such as a nose fairing, an under tray, or a boat tail or trailer tail. Would a standard trailer including these additional components make the tractor program better?

Another proposed aerodynamic test procedure improvement is intended to better account for average wind yaw angle to better reflect the true impact of aerodynamic features on the in-use fuel consumption and CO_2 emissions of tractors. Refer to the proposed test procedures in 40 CFR 1037.525 for further details of these aerodynamic test procedures.

For trailer certification, the agencies are proposing to use GEM in a different way than GEM is used for tractor certification in Phase 1 and Phase 2. As described in Section IV, the proposed trailer standards are based on GEM simulation, but trailer manufacturers would not run GEM for certification. Instead, manufacturers would use a simple equation to replicate GEM performance from the inputs. As with GEM, the only technologies recognized by this GEM-based equation for trailer certification are aerodynamic technologies, tire technologies (including tire rolling resistance and automatic tire inflation systems), and some weight reduction technologies. Note that since the purpose of this equation is to measure GEM performance, it can be considered as simply another form of the model using a different input interface. Thus, for simplicity, the remainder of this Section II. C. sometimes discusses GEM as being used for trailers, without regard to how manufacturers will actually input GEM variables.

Similar to tractor certification, we propose that trailer manufacturers may at their option conduct some amount of aerodynamic testing (*e.g.,* coast-down testing, scale wind tunnel testing, computational fluid dynamics modeling, or possibly aerodynamic component testing) and use this information with the equation.[92] In this

[91] NACFE. Executive Report—6x2 (Dead Axle) Tractors. November 2010. See Docket EPA–HQ–OAR–2014–0827.

[92] The agencies project that more than enough aerodynamic component vendors would take advantage of proposed optional pre-approval

case the agencies propose the configuration of a reference tractor for conducting trailer testing. Refer to Section IV of this preamble and to 40 CFR 1037.501 of the proposed regulations for details on the proposed reference tractor configuration for trailer test procedures.

(f) Tires and Tire Inflation Systems for Truck and Trailer Certification

For GEM in Phase 1 vehicle manufacturers input the tire rolling resistance of steer and drive tires directly into GEM. The agencies prescribed an internationally recognized tire rolling resistance test procedure, ISO 28580, for determining the tire rolling resistance value that is input into GEM, as described in 40 CFR 1037.520(c). For Phase 2 we are proposing to continue this same approach and the use of ISO 28580, and we propose to expand these requirements to trailer tires as well. We request comment on whether specific modifications to this test procedure would improve its accuracy, repeatability or its test lab to test lab variability.

In addition to tire rolling resistance, we are proposing that for Phase 2 vehicle manufacturers enter into GEM the tire manufacturer's specified tire loaded radius for the vehicle's drive tires. This value is commonly reported by tire manufacturers already so that vehicle speedometers can be adjusted appropriately. This input value is needed so that GEM can accurately convert simulated vehicle speed into axle speed, transmission speed, and ultimately engine speed. We request comment on whether the proposed test procedure should be modified to measure the tire's revolutions per distance directly, as opposed to using the loaded radius to calculate the drive axle rotational speed from vehicle speed.

For tractors and trailers, we propose to allow manufacturers to specify whether or not an automatic tire inflation system is installed. If one is installed, GEM, or in the case of trailers, the equations based on GEM, would assign a 1 percent decrease in the overall fuel consumption and CO_2 emissions simulation results for tractors, and a 1.5 percent decrease for trailers. This would be done through post-simulation adjustments discussed in Chapter 4 of the draft RIA. In contrast, we are not proposing to assign any decrease in fuel consumption and CO_2 emissions for tire pressure monitoring systems. We do recognize that some drivers would respond to a warning indication from a tire pressure monitoring system, but we are unsure how to assign a fixed decrease in fuel consumption and CO_2 emissions for tire pressure monitoring systems. We would estimate that the value would be less than any value we would assign for an automatic tire inflation system. We request comment on whether or not we should assign a fixed decrease in fuel consumption and CO_2 emissions for tire pressure monitoring systems, and if so, we request comment on what would be an appropriate assigned fixed value.

(g) Weight Reduction for Tractor, Vocational Chassis and Trailer Certification

We propose for Phase 2 that GEM continues the weight reduction recognition approach in Phase 1, where the agencies prescribe fixed weight reductions, or ''deltas'', for using certain lightweight materials for certain vehicle components. In Phase 1 the agencies published a list of weight reductions for using high-strength steel and aluminum materials on a part by part basis. For Phase 2 we propose to use these same values for high-strength steel and aluminum parts for tractors and for trailers and we have scaled these values for use in certifying the different weight classes of vocational chassis. In addition we are proposing a similar part by part weight reduction list for tractor parts made from thermoplastic material. We are also proposing to assign a fixed weight increase to natural gas fueled vehicles to reflect the weight increase of natural gas fuel tanks versus gasoline or diesel tanks. This increase would be allocated partly to the chassis and from the payload using the same allocation as weight reductions for the given vehicle type. For tractors we are proposing to continue the same mathematical approach in GEM to assign 1/3 of a total weight decrease to a payload increase and 2/3 of the total weight decrease to a vehicle mass decrease. For Phase 1 these ratios were based on the average frequency that a tractor operates at its gross combined weight rating. Therefore, we propose to use these ratios for trailers in Phase 2. However, as with the other fuel consumption and GHG reducing technologies manufacturers use for compliance, reductions associated with weight reduction would be calculated using the trailer compliance equation rather than GEM. For vocational chassis, for which Phase 1 did not address weight reduction, we propose a 50/50 ratio. In other words, for vocational chassis in GEM we propose to assign 1/2 of a total weight decrease to a payload increase and 1/2 of the total weight decrease to a vehicle mass decrease. We request comment on all aspects of applying weight reductions in GEM, including proposed weight increases for alternate fuel vehicles and whether a 50/50 ratio is appropriate for vocational chassis.

(h) GEM Duty Cycles for Tractor, Vocational Chassis and Trailer Certification

In Phase 1, there are three GEM vehicle duty cycles that represented stop-and-go city driving (ARB Transient), urban highway driving (55 mph), and rural interstate highway driving (65 mph). In Phase 1 these cycles were time-based. That is, they were specified as a function of simulated time and the duty cycles ended once the specified time elapsed in simulation. The agencies propose to use these three drive cycles in Phase 2, but with some revisions. First the agencies propose that GEM would simulate these cycles on a distance-based specification, rather than on a time-based specification. A distance-based specification ensures that even if a vehicle in simulation does not always achieve the target vehicle speed, the vehicle will have to continue in simulation for a longer period of time to complete the duty cycle. This ensures that vehicles are evaluated over the complete distance of the duty cycle and not just the portion of the duty cycle that a vehicle completes in a given time period. A distance-based duty cycle specification also facilitates a straightforward specification of road grade as a function of distance along the duty cycle. For Phase 2 the agencies are proposing to enhance the 55 mph and 65 mph duty cycles by adding representative road grade to exercise the simulated vehicle's engine, transmission, axle, and tires in a more realistic way. A flat road grade profile over a constant speed test does not present many opportunities for a transmission to shift gears, and may have the unintended consequence of enabling underpowered vehicles or excessively downsped drivetrains to generate credits. The road grade profile proposed is the same for both the 55 mph and 65 mph duty cycles, and the profile was based on real over-the-road testing the agencies directed under an agency-funded contract with Southwest Research Institute.[93] See Section III.E for more details on development of the proposed road grade profile. The agencies are continuing to evaluate

process to make trailer manufacturer testing optional.

[93] SwRI road grade testing and GEM validation report, 2014.

alternate road grade profiles including actual sections of restricted access highway with road grades that are statistically similar to the national road grade profile as well as purely synthetic road grade profiles.[94] We request comments on the proposed road grade profile, and would welcome additional statistical evaluations of this road grade profile and other road grade profiles for comparison. We believe that the enhancement of the 55 mph and 65 mph duty cycles with road grade is consistent with the NAS recommendation regarding road grade.[95]

We recognize that even with the proposed road grade profile, GEM may continue to under predict the number of transmission shifts of vehicles on restricted access highways if the model simulates constant speeds. We request comment on other ways in which the proposed 55 mph and 65 mph duty cycles could be enhanced. For example, we request comment on whether a more aggressive road grade profile would induce a more realistic and representative number of transmission gear shifts. We also request comment on whether we should consider varying the vehicle target speed over the 55 mph and/or 65 mph duty cycles to simulate human driver behavior reacting to traffic congestion. This would increase the number of shifts during the 55 mph and 65 mph duty cycles, though it may be possible for an equivalent effect to be achieved by assigning a greater weighting to the transient cycle in the GEM composite test score.

(i) Workday Idle Operation for Vocational Vehicle Certification

In the Phase 1 program, reduction in idle emissions was recognized only for sleeper cab tractors, and only with respect to hotelling idle, where a driver needs power to operate heating, ventilation, air conditioning and other electrical equipment in order to use the sleeper cab to eat, rest, or conduct other business. As described in Section V, the agencies are now proposing to recognize in GEM technologies that reduce workday idle emissions, such as automatic stop-start systems and automatic transmissions that shift to neutral at idle. Many vocational vehicle applications operate on patterns implicating workday idle cycles, and the agencies are proposing test procedures in GEM to account specifically for these cycles and potential controls. GEM would recognize these idle controls in two ways. For technologies like neutral-idle that address idle that occurs during the transient cycle (representing the type of operation that would occur when the vehicle is stopped at a stop light), GEM would interpolate lower fuel rates from the engine map. For technologies like start-stop and auto-shutdown that eliminate some of the idle that occurs when a vehicle is stopped or parked, GEM would assign a value of zero fuel rate for what we are proposing as an ''idle cycle''. This idle cycle would be weighted along with the 65 mph, 55 mph, and ARB Transient duty cycles according to the vocational chassis duty cycle weighting factors that we are proposing for Phase 2. These weighting factors are different for each of the three vocational chassis speed categories that we are proposing for Phase 2. While we are not proposing to apply this idle cycle for tractors, we do request comment on whether or not we should consider a applying this idle cycle to certain tractor types, like day cabs that could experience more significant amounts of time stopped or parked as part of an urban delivery route. We also request comment on whether or not start-stop or auto-shutdown technologies are being developed for tractors; especially for Class 7 and 8 day cabs that could experience more frequent stops and more time parked for deliveries.

(2) Validation of the Proposed GEM

After making the proposed changes to GEM, the agencies validated the model in comparison to over 130 vehicle variants, consistent with the recommendation made by the NAS in their Phase 2-First Report.[96] As is described in Chapter 4 of the Draft RIA, good agreement was observed between GEM simulations and test data over a wide range of vehicles. In general, the model simulations agreed with the test results within ±5 percent on an absolute basis. As pointed out in Chapter 4.3.2 of the RIA, relative accuracy is more relevant to this rulemaking. This is because all of the numeric standards proposed for tractors, trailers and vocational chassis are derived from running GEM first with Phase 1 ''baseline'' technology packages and then with various candidate Phase 2 technology packages. The differences between these GEM results are examined to select stringencies. In other words, the agencies used the same version of GEM to establish the standards as was used to evaluate baseline performance for this rulemaking. Therefore, it is most important that GEM accurately reflects relative changes in emissions for each added technology. For vehicle certification purposes it is less important that GEM's absolute value of the fuel consumption or CO_2 emissions are accurate compared to laboratory testing of the same vehicle. The ultimate purpose of this new version of GEM will be to evaluate *changes* or *additions* in technology, and compliance is demonstrated on a relative basis to the numerically standards that were also derived from GEM. Nevertheless, the agencies concluded that the absolute accuracy of GEM is generally within ±5 percent, as shown in Figure II–1. Chapter 4.3.2 of the draft RIA shows that relative accuracy is even better, ±2–3 percent.

[94] See National Renewable Energy Laboratory report ''EPA GHG Certification of Medium- and Heavy-Duty Vehicles: Development of Road Grade Profiles Representative of US Controlled Access Highways'' dated May 2015 and EPA memorandum ''Development of an Alternative, Nationally Representative, Activity Weighted Road Grade Profile for Use in EPA GHG Certification of Medium- and Heavy-Duty Vehicles'' dated May 13, 2015, both available in Docket EPA–HQ–OAR–2014–0827. This docket also includes file NREL_SyntheticAndLocalGradeProfiles.xlsx which contains numerical representations of all road grade profiles described in the NREL report.

[95] NAS 2010 Report. Page 189. ''A fundamental concern raised by the committee and those who testified during our public sessions was the tension between the need to set a uniform test cycle for regulatory purposes, and existing industry practices of seeking to minimize the fuel consumption of medium and heavy-duty vehicles designed for specific routes that may include grades, loads, work tasks or speeds inconsistent with the regulatory test cycle. This highlights the critical importance of achieving fidelity between certification values and real-world results to avoid decisions that hurt rather than help real-world fuel consumption.''

[96] National Academy of Science. ''Reducing the Fuel Consumption and GHG Emissions of Medium- and Heavy-Duty Vehicles, Phase Two, First Report.'' 2014. Recommendation1.2.

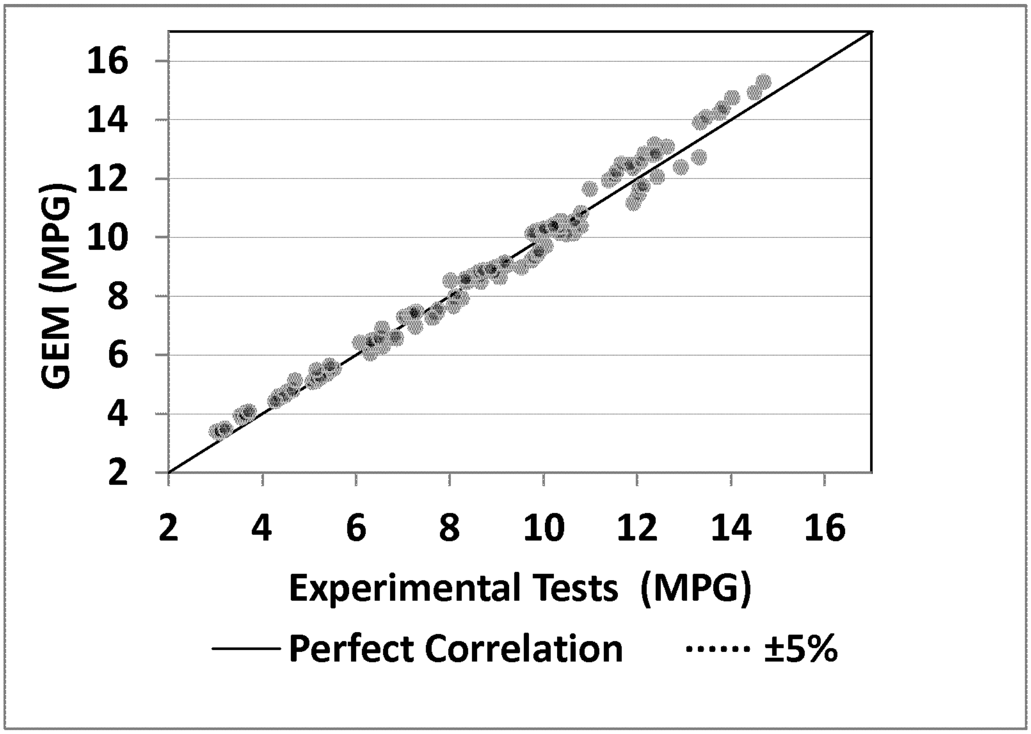

Figure II-1 GEM Validation Data

In addition to this successful validation against experimental results, the agencies have also initiated a peer review of the proposed GEM source code. This peer review has been submitted to Docket # EPA–HQ–OAR–2014–0827.

(3) Supplements to GEM Simulation

As in Phase 1, for most tractors and vocational vehicles, compliance with the Phase 2 g/ton-mile vehicle standards could be evaluated by directly comparing the GEM result to the standard. However, in Phase 1, manufacturers incorporating innovative or advanced technologies could apply improvement factors to lower the GEM result slightly before comparing to the standard.[97] For example, a manufacturer incorporating a launch-assist mild hybrid that was approved for a 5 percent benefit would apply a 0.95 improvement factor to its GEM results for such vehicles. In this example, a GEM result of 300 g/ton-mile would be reduced to 285 g/ton-mile.

For Phase 2, the agencies are proposing to largely continue the existing Phase 1 innovative technology approach. We are also proposing to create a parallel option specifically related to innovative powertrain designs. These proposals are discussed below.

(a) Innovative/Off-Cycle Technology Procedures

In Phase 1 the agencies adopted an emissions credit generating opportunity that applied to new and innovative technologies that reduce fuel consumption and CO_2 emissions, that were not in common use with heavy-duty vehicles before model year 2010 and are not reflected over the test procedures or GEM (*i.e.,* the benefits are ‘‘off-cycle’’). See 76 FR 57253. As was the case in the development of Phase 1, the agencies are proposing to continue this approach for technologies and concepts with CO_2 emissions and fuel consumption reduction potential that might not be adequately captured over the proposed Phase 2 duty cycles or are not proposed inputs to GEM. Note, however, that the agencies are proposing to refer to these technologies as off-cycle rather than innovative. See Section I for more discussion of innovative and off-cycle technologies.

We recognize that the Phase 1 testing burden associated with the innovative technology credit provisions discouraged some manufacturers from applying. To streamline recognition of many technologies, default values have been integrated directly into GEM. For example, automatic tire inflation systems and 6x2 axles both have fixed default values, recognized through a post-simulation adjustment approach discussed in Chapter 4 of the draft RIA. This is similar to the technology ‘‘pick list’’ from our light-duty programs. See 77 FR 62833–62835 (October 15, 2012). If manufacturers wish to receive additional credit beyond these fixed values, then the innovative/off-cycle technology credit provisions would provide the regulatory path toward that additional recognition.

Beyond the additional technologies that the agencies have added to GEM, the agencies also believe there are several emerging technologies that are being developed today, but would not be accounted for in GEM as we are proposing it because we do not have enough information about these technologies to assign fixed values to them in GEM. Any credits for these technologies would need to be based on the off-cycle technology credit generation provisions. These require the assessment of real-world fuel consumption and GHG reductions that can be measured with verifiable test methods using representative operating conditions typical of the engine or vehicle application.

As in Phase 1, the agencies are proposing to continue to provide two

[97] 40 CFR 1036.610, 1036.615, 1037.610, and 1037.615

paths for approval of the test procedure to measure the CO_2 emissions and fuel consumption reductions of an off-cycle technology used in the HD tractor. See 40 CFR 1037.610 and 49 CFR 535.7. The first path would not require a public approval process of the test method. A manufacturer can use ''pre-approved'' test methods for HD vehicles including the A-to-B chassis testing, powerpack testing or on-road testing. A manufacturer may also use any developed test procedure which has known quantifiable benefits. A test plan detailing the testing methodology is required to be approved prior to collecting any test data. The agencies are also proposing to continue the second path which includes a public approval process of any testing method which could have questionable benefits (*i.e.,* an unknown usage rate for a technology). Furthermore, the agencies are proposing to modify its provisions to better clarify the documentation required to be submitted for approval aligning them with provisions in 40 CFR 86.1869–12, and NHTSA is separately proposing to prohibit credits from technologies addressed by any of its crash avoidance safety rulemakings (*i.e.,* congestion management systems). We welcome recommendations on how to improve or streamline the off-cycle technology approval process.

Sections III and V describe tractor and vocational vehicle technologies, respectively, that the agencies anticipate may qualify for these off-cycle credit provisions.

(b) Powertrain Testing

The agencies are proposing a powertrain test option to allow for a robust way to quantify the benefits of CO_2 reducing technologies that are a part of the powertrain (conventional or hybrid) that are not captured in the GEM simulation. Powertrain testing and certification was included as one of the NAS recommendations in the Phase 2 –First Report.[98] Some of these improvements are transient fuel control, engine and transmission control integration and hybrid systems. To limit the amount of testing, the powertrain would be divided into families and powertrains would be tested in a limited number of simulated vehicles that cover the range of vehicles in which the powertrain would be installed. The powertrain test results would then be used to override the engine and transmission simulation portion of GEM.

The largest proposed change from the Phase 1 powertrain procedure is that only the advanced powertrain would need to be tested (as opposed to the Phase 1 requirement where both the advanced powertrain and the conventional powertrain had to be tested). This change is possible because the proposed GEM simulation uses the engine fuel map and torque curve from the actual engine in the vehicle to be certified. For the powertrain results to be used broadly across all the vehicles that the powertrain would go into, a matrix of 8 to 9 tests would be needed per vehicle cycle. These tests would cover the range of coefficient of drag, coefficient of rolling resistance, vehicle mass and axle ratio of the vehicles that the powertrain will be installed in. The main output of this matrix of tests would be fuel mass as a function of positive work and average transmission output speed over average vehicle speed. This matrix of test results would then be used to calculate the vehicle's CO_2 emissions by taking the work per ton-mile from the GEM simulation and multiplying it by the interpolated work specific fuel mass from the powertrain test and mass of CO_2 to mass of fuel ratio.

Along with proposing changes to how the powertrain results are used, the agencies are also proposing changes to the procedures that describe how to carry out a powertrain test. The changes are to give additional guidance on controlling the temperature of the powertrains intake-air, oil, coolant, block, head, transmission, battery, and power electronics so that they are within their expected ranges for normal operation. The equations that describe the vehicle model are proposed to be changed to allow for input of the axle's efficiency, driveline rotational inertia, as well as the mechanical and electrical accessory loads.

The determine the positive work and average transmission output speed over average vehicle speed in GEM for the vehicle that will be certified, the agencies have defined a generic powertrain for each vehicle category. The agencies are requesting comment on if the generic powertrains should be modified according to specific aspects of the actual powertrain. For example using the engine's rated power to scale the generic engine's torque curve. Similarly, the transmission gear ratios could be scaled by the axle ratio of the drive axle, to make sure the generic engine is operated in GEM at the correct engine speed.

(4) Production Vehicle Testing for Comparison to GEM

The agencies are is proposing to require tractor and vocational vehicle manufacturers to annually chassis test 5 production vehicles over the GEM cycles to verify that relative reductions simulated in GEM are being achieved in actual production. See 40 CFR 1037.665. We would not expect absolute correlation between GEM results and chassis testing. GEM makes many simplifying assumptions that do not compromise its usefulness for certification, but do cause it to produce emission rates different from what would be measured during a chassis dynamometer test. Given the limits of correlation possible between GEM and chassis testing, we would not expect such testing to accurately reflect whether a vehicle was compliant with the GEM standards. Therefore, we are proposing to not apply compliance liability to such testing. Rather, this testing would be for informational purposes only. However, we do expect there to be correlation in a relative sense. Vehicle to vehicle differences showing a 10 percent improvement in GEM should show a similar percent improvement with chassis dynamometer testing. Nevertheless, manufacturers would not be subject to recall or other compliance actions if chassis testing did not agree with the GEM results on a relative basis. Rather, the agencies would continue evaluate in-use compliance by verifying GEM inputs and testing in-use engines.

EPA believes this chassis test program is necessary because of our experience implementing regulations for heavy-duty engines. In the past, manufacturers have designed engines that have much lower emissions on the duty cycles than occur during actual use. By proposing this simple test program, we hope to be able to identify such issues earlier and to dissuade any attempts to design solely to the certification test. We also expect the results of this testing to help inform the need for any further changes to GEM.

As already noted in Section II.B.(1), it can be expensive to build chassis test cells for certification. However, EPA is proposing to structure this pilot-scale program to minimize the costs. First, we are proposing that this chassis testing would not need to comply with the same requirements as would apply for official certification testing. This would allow testing to be performed in developmental test cells with simple portable analyzers. Second, since the proposed program would require only 5 tests per year, manufacturers without

[98] National Academy of Science. ''Reducing the Fuel Consumption and GHG Emissions of Medium- and Heavy-Duty Vehicles, Phase Two, First Report.'' 2014. Recommendation 1.6. However, the agencies are not proposing to allow for the use of manufacturer derived and verified models of the powertrain within GEM.

their own chassis testing facility would be able to contract with a third party to perform the testing. Finally, EPA proposes to apply this testing to only those manufacturers with annual production in excess of 20,000 vehicles.

We request comment on this proposed testing requirement. Commenters are encouraged to suggest alternate approaches that could achieve the assurance that the projected emissions reductions would occur in actual use.

(5) Use of GEM in Establishing Proposed Numerical Standards

Just like in Phase 1, the agencies are proposing specific numerical standards against which tractors and vocational vehicles would be evaluated using GEM (We propose that trailers use a simplified equation-based approach that was derived from GEM). Although the proposed standards are performance-based standards, which do not specifically require the use of any particular technologies, the agencies established the proposed standards by evaluating specific vehicle technology packages using a prepublication version of the Phase 2 GEM. This prepublication version was an intermediate version of the GEM source code, rather than the executable file version of GEM, which is being docketed for this proposal and is available on EPA's GEM Web page. Both the GEM source code and the GEM executable file are generally functionally equivalent.

The agencies determined the proposed numerical standards essentially by evaluating certain specific technology packages representing the packages we are projecting to be feasible in the Phase 2 time frame. For each technology package, GEM was used determine a cycle-weighted g/ton-mile emission rate and a gal/1,000 ton-mile fuel consumption rate. These GEM results were then essentially averaged together, weighted by the adoption rates the agencies are projecting for each technology package and for each model year of standards. Consider as an oversimplified example of two technology packages for Class 8 low-roof sleepers cabs: one package that resulted in 60 g/ton-mile and a second that resulted in 80 g/ton-mile. If we project that the first package could be applied to 50 percent of the Class 8 low-roof sleeper cab fleet in MY 2027, and that the rest of the fleet could do no better than the second technology package, then we would set the fleet average standard at 70 g/ton-mile ($0.5 \cdot 60 + 0.5 \cdot 80 = 70$).

Formal external peer review and expert external user review was then conducted on the version of the GEM source code that was used to calculate the numerical values of the proposed standards. It was discovered via these external review processes that the GEM source code contained some minor software ''bugs.'' These bugs were then corrected by EPA and the Phase 2 proposed GEM executable file was derived from this corrected version of the GEM source code. Moreover, we expect to also receive technical comments during the comment period that could potentially identify additional GEM software bugs, which would lead EPA to make additional changes to GEM before the Final Rule. Nevertheless, EPA has repeated the analysis described above using the corrected version of the GEM source code that was used to create the proposed GEM executable file. The results of this analysis are available in the docket to this proposal.[99]

Thus, even without the agencies making any changes in our projections of technology effectiveness or market adoption rates, it is likely that further revisions to GEM could result in us finalizing different numerical values for the standards. It is important to note that the agencies would not necessarily consider such GEM-based numerical changes by themselves to be changes in the stringency of the standards. Rather, we believe that stringency is more appropriately evaluated in technological terms; namely, by evaluating technology effectiveness and the market adoption rates of technologies. Nevertheless, the agencies will docket any updates and supporting information in a timely manner.

D. Proposed Engine Test Procedures and Engine Standards

For the most part, the proposed Phase 2 engine standards are a continuation of the Phase 1 program, but with more stringent standards for compression-ignition engines. Nevertheless, the agencies are proposing important changes related to the test procedures and compliance provisions. These changes are described below.

As already discussed in Section II.B. the agencies are proposing a regulatory structure in which engine technologies are evaluated using engine-specific test procedures as well using GEM, which is vehicle-based. We are proposing separate standards for each procedure. The proposed engine standards described in Section II.D.(2) and the proposed vehicle standards described in Sections III and V are based on the same engine technology, which is described in Section II.D.(2). We request comment on whether the engine and vehicle standards should be based on the same projected technology. As described below, while the agencies projected the same engine technology for engine standards and for vehicle standards, we separately projected the technology that would be appropriate for:

- Gasoline vocational engines and vehicles
- Diesel vocational engines and vehicles
- Tractor engines and vehicles

Before addressing the engine standards and engine technology in Section II.D.(2), the agencies describe the test procedures that would be used to evaluate these technologies in Section II.D.(1) below. We believe that without first understanding the test procedures, the numerical engine standards would not have the proper context.

(1) Engine Test Procedures

The Phase 1 engine standards relied on the engine test procedures specified in 40 CFR part 1065. These procedures were previously used by EPA to regulate criteria pollutants such as NO_X and PM, and few changes were needed to employ them for purposes of the Phase 1 standards. The agencies are proposing significant changes to two areas for Phase 2: (1) cycle weighting; and (2) GEM inputs. (Note that EPA is also proposing some minor changes to the basic part 1065 test procedures, as described in Section XIII).

The diesel (*i.e.,* compression-ignition) engine test procedure relies on two separate engine test cycles. The first is the Heavy-duty Federal Test Procedure (Heavy-duty FTP) that includes transient operation typified by frequent accelerations and decelerations, similar to urban or suburban driving. The second is the Supplemental Engine Test (SET) which includes 13 steady-state test points. The SET was adopted by EPA to address highway cruise operation and other nominally steady-state operation. However, it is important to note that it was intended as a supplemental test cycle and not necessarily to replicate precisely any specific in-use operation.

The gasoline (*i.e.,* spark-ignition) engine test procedure relies on a single engine test cycle: a gasoline version of Heavy-duty FTP. The agencies are not proposing changes to the gasoline engine test procedures.

It is worth noting that EPA sees great value in using the same test procedures for measuring GHG emissions as is used

[99] *See* Memorandum to the Docket ''Numerical Standards for Tractors, Trailers, and Vocational Vehicles Based on the June 2015 GEM Executable Code.

for measuring criteria pollutants. From the manufacturers' perspective, using the same procedures minimizes their test burden. However, EPA sees additional benefits. First, as already noted in Section(b), requiring engine manufacturers to comply with both NO_X and CO_2 standards using the same test procedures discourages alternate calibrations that would trade NO_X emissions against fuel consumption depending how the engine or vehicle is tested. Second, this approach leverages the work that went into developing the criteria pollutant cycles. Taken together, these factors support our decision to continue to rely on the 40 CFR part 1065 test procedures with only minor adjustments, such as those described in Section II.D.(1)(a). Nevertheless, EPA would consider more substantial changes if they were necessary to incentivize meaningful technology changes, similar to the changes being made to GEM for Phase 2 to address additional technologies.

(a) SET Cycle Weighting

The SET cycle was adopted by EPA in 2000 and modified in 2005 from a discrete-mode test to a ramped-modal cycle to broadly cover the most significant part of the speed and torque map for heavy-duty engines, defined by three non-idle speeds and three relative torques. The low speed is often called the ''A speed'', the intermediate speed is often called the ''B speed'', and the high speed is often called the ''C speed.'' As is shown in Table II–1, the SET weights these three speeds at 23 percent, 39 percent, and 23 percent.

TABLE II–1—SET MODES WEIGHTING FACTOR IN PHASE 1

Speed, % load	Weighting factor in Phase 1 (%)
Idle	15
A, 100	8
B, 50	10
B, 75	10
A, 50	5
A, 75	5
A, 25	5
B, 100	9
B, 25	10
C, 100	8
C, 25	5
C, 75	5
C, 50	5
Total	100
Total A Speed	23
Total B Speed	39
Total C Speed	23

The C speed is typically in the range of 1800 rpm for current HHD engine designs. However, it is becoming less common for engines to operate often in such a high speed in real world driving condition, and especially not during cruise vehicle speed between 55 and 65 mph. The agencies receive confidential business information from a few vehicle manufacturers that support this observation. Thus, although the current SET represents highway operation better than the FTP cycle, it is not an ideal cycle to represent future highway operation. Furthermore, given the recent trend configure drivetrains to operate engines at speeds down to a range of 1150–1200 rpm at vehicle speed of 65mph. This trend would make the typical highway engine speeds even further away from C speed.

To address this issue, the agencies are proposing new weighting factors for the Phase 2 GHG and fuel consumption standards. The proposed new SET mode weightings move most of C weighting to ''A'' speed, as shown in Table II–2. It would also slightly reduce the weighting factor on the idle speed.

The agencies request comment on the proposed reweighting.

TABLE II–2—PROPOSED SET MODES WEIGHTING FACTOR IN PHASE 2

Speed, % load	Proposed weighting factor in Phase 2 (%)
Idle	12
A, 100	9
B, 50	10
B, 75	10
A, 50	12
A, 75	12
A, 25	12
B, 100	9
B, 25	9
C, 100	2
C, 25	1
C, 75	1
C, 50	1
Total	100
Total A Speed	45
Total B Speed	38
Total C Speed	5

(b) Measuring GEM Engine Inputs

Although GEM does not apply directly to engine certification, implementing the Phase 2 GEM would impact engine manufacturers. To recognize the contribution of the engine in GEM the engine fuel map, full load torque curve and motoring torque curve have to be input into GEM. To insure the robustness of each of those inputs, a standard procedure has to be followed. Both the full load and motoring torque curve procedures are already defined in 40 CFR part 1065 for engine testing. However, the fuel mapping procedure being proposed would be new. The agencies have compared the proposed procedure against other accepted engine mapping procedures with a number of engines at various labs including EPA's NVFEL, Southwest Research Institute sponsored by the agencies, and Environment Canada's laboratory.[100] The proposed procedure was selected because it proved to be accurate and repeatable, while limiting the test burden to create the fuel map. This proposed provision is consistent with NAS's recommendation (3.8).

One important consideration is the need to correct measured fuel consumption rates for the carbon and energy content of the test fuel. For engine tests, we propose to continue the Phase 1 approach, which is specified in 40 CFR 1036.530. We propose a similar approach to GEM fuel maps in Phase 2.

The agencies are proposing that engine manufacturers must certify fuel maps as part of their certification to the engine standards, and that they be required to provide those maps to vehicle manufacturers beginning with MY 2020.[101] The one exception to this requirement would be for cases in which the engine manufacturer certifies based on powertrain testing, as described in Section (c). In such cases, engine manufacturers would not be required to also certify the otherwise applicable fuel maps. We are not proposing that vehicle manufacturers be allowed to develop their own fuel maps for engines they do not manufacture.

The current engine test procedures also require the development of regeneration emission rate and frequency factors to account for the emission changes for criteria pollutants during a regeneration event. In Phase 1, the agencies adopted provisions to exclude CO_2 emissions and fuel consumption due to regeneration. However, for Phase 2, we propose to include CO_2 emissions and fuel consumption due to regeneration over the FTP and RMC cycles as determined using the infrequently regenerating aftertreatment devices (IRAF) provisions in 40 CFR 1065.680. We do not believe this would significantly impact the stringency of the proposed standards

[100] US EPA, ''Technical Research Workshop supporting EPA and NHTSA Phase 2 Standards for MD/HD Greenhouse Gas and Fuel Efficiency—December 10 and 11, 2014,'' *http://www.epa.gov/otaq/climate/regs-heavy-duty.htm.*

[101] Current normal vehicle manufacturing processes generally result in many vehicles being produced with prior model year engines. For example, we expect that some MY 2021 vehicles will be produced with MY 2020 engines. Thus, we are proposing to require engine manufacturers to begin providing fuel maps in 2020 so that vehicle manufacturers could run GEM to certify MY 2021 vehicles with MY 2020 engines.

because manufacturers have already made great progress in reducing the impact of regeneration emissions since 2007. Nevertheless, we believe it would be prudent to begin accounting for regeneration emissions to discourage manufacturers from adopting compliance strategies that would reverse this trend. We request comment on this requirement.

We are not proposing, however, to include fuel consumption due to regeneration in the creation of the fuel map used in GEM for vehicle compliance. We believe that the proposed requirements for the duty-cycle standards, along with market forces that already exist, would create sufficient incentives to reduce fuel consumption during regeneration over the entire fuel map.

(c) Engine Test Procedures for Replicating Powertrain Tests

As described in Section II.B.(2)(b), the agencies are proposing a powertrain test option to quantify the benefits of CO_2 reducing powertrain technologies. These powertrain test results would then be used to override the engine and transmission simulation portion of GEM. The agencies are proposing to require that any manufacturer choosing to use this option also measure engine speed and engine torque during the powertrain test so that the engine's performance during the powertrain test could be replicated in a non-powertrain engine test cell. Subsequent engine testing would be conducted using the normal part 1065 engine test procedures, and g/hp-hr CO_2 results would be compared to the levels the manufacturer reported during certification. Such testing would apply for both confirmatory and selective enforcement audit testing.

Under the proposed regulations, engine manufacturers certifying powertrain performance (instead of or in addition to the multi-point fuel maps) would be held responsible for powertrain test results. If the engine manufacturer does not certify powertrain performance and instead certifies only the multi-point fuel maps, it would held responsible for fuel map performance rather than the powertrain test results. Engine manufacturers certifying both would be responsible for both.

(d) CO_2 From Urea SCR Systems

For diesel engines utilizing urea SCR emission control systems for NO_X reduction, the agencies are proposing to allow correction of the final engine fuel map and powertrain duty cycle CO_2 emission results to account for the contribution of CO_2 from the urea injected into the exhaust. This urea could contribute up to 1 percent of the total CO_2 emissions from the engine. Since current urea production methods use gaseous CO_2 captured from the atmosphere (along with NH_3), CO_2 from urea consumption does not represent a net carbon emission. This adjustment is necessary so that fuel maps developed from CO_2 measurements would be consistent with fuel maps from direct measurements of fuel flow rates. Thus, we are only proposing to allow this correction for emission tests where CO_2 emissions are determined from direct measurement of CO_2 and not from fuel flow measurement, which would not be impacted by CO_2 from urea.

We note that this correction would be voluntary for manufacturers, and expect that some manufacturers may determine that the correction is too small to be of concern. The agencies will use this correction with any engines for which the engine manufacturer applied the correction for its fuel maps during certification.

We are not proposing this correction for engine test results with respect to the engine CO_2 standards. Both the Phase 1 standards and the proposed standards for CO_2 from diesel engines are based on test results that included CO_2 from urea. In other words, these standards are consistent with using a test procedure that does not correct for CO_2 from urea. We request comment on whether it would be appropriate to allow this correction for the Phase 2 engine CO_2 standards, but also adjust the standards to reflect the correction. At this time, we believe that reducing the numerical value of the CO_2 standards by 1 g/hp-hr would make the standards consistent with measurement that are corrected for CO_2 from urea. However, we also request comment on the appropriateness of applying a 2 g/hp-hr adjustment should we determine it would better reflect the urea contribution for current engines.

(e) Potential Alternative Certification Approach

In Section II.B.(2)(b), we explained that although GEM does not apply directly to engine certification, implementing the Phase 2 GEM would impact engine manufacturers by requiring that they measure engine fuel maps. In Section II.B.(2), the agencies noted that some stakeholders may have concerns about the proposed regulatory structure that would require engine manufacturers to provide detailed fuel consumption maps for GEM. Given such concerns, the agencies are requesting comment on an approach that could mitigate the concerns by allowing both vehicle and engine to use the same driving cycles for certification. The detailed description of this alternative certification approach can be seen in the draft RIA. We are requesting comment on allowing this approach as an option, or as a replacement to the proposed approach. Commenters supporting this approach should address possible impacts on the stringency of the proposed standards.

This approach utilizes GEM with a default engine fuel map pre-defined by the agency to run a number of pre-defined vehicle configurations over three certification cycles. Engine torque and speed profile would be obtained from the simulations, and would be used to specify engine dynamometer commands for engine testing. The results of this testing would be a CO_2 map as function of the integrated work and the ratio of averaged engine speed (N) to averaged vehicle speed (V) defined as (N/V) over each certification cycle. In vehicle certification, vehicle manufacturers would run GEM with the to-be-certified vehicle configuration and the agency default engine fuel map separately for each GEM cycle. Applying the total work and N/V resulted from the GEM simulations to the CO_2 map obtained from engine tests would determine CO_2 consumption for vehicle certification. For engine certification, we are considering allowing the engine to be certified based on one of the points conducted during engine alternative CO_2 map tests mentioned above rather than based on the FTP and SET cycle testing.

(2) Proposed Engine Standards for CO_2 and Fuel Consumption

We are proposing to maintain the existing Phase 1 regulatory structure for engine standards, which had separate standards for spark-ignition engines (such as gasoline engines) and compression-ignition engines (such as diesel engines), but we are proposing changes to how these standards would apply to natural gas fueled engines. As discussed in Section II.B.(2)(b), the agencies see important advantages to maintaining separate engines standards, such as improved compliance assurance and better control during transient engine operation.

Phase 1 also applied different test cycles depending on whether the engine is used for tractors, vocational vehicles, or both, and we propose to continue this as well.[102] We assume that CO_2 at the

[102] Engine classification is set forth in 40 CFR 1036.801. Spark-ignition means relating to a

Continued

end of Phase 1 is the baseline of Phase 2. Table II–3 shows the Phase 1 CO_2 standards for diesel engines, which serve as the baseline for our analysis of the proposed Phase 2 standards.

TABLE II–3—PHASE 2 BASELINE CO_2 PERFORMANCE

(g/bhp-hr)

LHDD–FTP	MHDD–FTP	HHDD–FTP	MHDD–SET	HHDD–SET
576	576	555	487	460

The gasoline engine baseline CO_2 is 627 (g/bhp-hr). The agencies used the baseline engine to assess the potential of the technologies described in the following sections. As described below, the agencies are proposing new compression-ignition engine standards for Phase 2 that would require additional reductions in CO_2 emissions and fuel consumption beyond the baseline. However, as also described below in Section II.B.(2)(b), we are not proposing more stringent CO_2 or fuel consumption standards for new heavy-duty gasoline engines. Note, however, that we are projecting some small improvement in gasoline engine performance that would be recognized over the vehicle cycles.

For heavy-heavy-duty diesel engines to be installed in Class 7 and 8 combination tractors, the agencies are proposing the standards shown in Table II–4.[103] The proposed MY 2027 standards for engines installed in tractors would require engine manufacturers to achieve, on average, a 4.2 percent reduction in fuel consumption and CO_2 emissions beyond the Phase 1 standard. We propose to adopt interim engine standards in MY 2021 and MY 2024 that would require diesel engine manufacturers to achieve, on average, 1.5 percent and 3.7 percent reductions in fuel consumption and CO_2 emissions, respectively.

TABLE II–4—PROPOSED PHASE 2 HEAVY-DUTY TRACTOR ENGINE STANDARDS FOR ENGINES[104] OVER THE SET CYCLE

Model year	Standard	Medium heavy-duty diesel	Heavy heavy-duty diesel
2021–2023	CO_2 (g/bhp-hr)	479	453
	Fuel Consumption (gallon/100 bhp-hr)	4.7053	4.4499
2024–2026	CO_2 (g/bhp-hr)	469	443
	Fuel Consumption (gallon/100 bhp-hr)	4.6071	4.3517
2027 and Later	CO_2 (g/bhp-hr)	466	441
	Fuel Consumption (gallon/100 bhp-hr)	4.5776	4.3320

Forcompression-ignition engines fitted into vocational vehicles, the agencies are proposing MY 2027 standards that would require engine manufacturers to achieve, on average, a 4.0 percent reduction in fuel consumption and CO_2 emissions beyond the Phase 1 standard. We propose to adopt interim engine standards in MY 2021 and MY 2024 that would require diesel engine manufacturers to achieve, on average, 2.0 percent and 3.5 percent reductions in fuel consumption and CO_2 emissions, respectively.

Table II–5 presents the CO_2 and fuel consumption standards the agencies propose for compression-ignition engines to be installed in vocational vehicles. The first set of standards would take effect with MY 2021, and the second set would take effect with MY 2024.

TABLE II–5—PROPOSED VOCATIONAL DIESEL ENGINE STANDARDS OVER THE HEAVY-DUTY FTP CYCLE

Model year	Standard	Light heavy-duty diesel	Medium heavy-duty diesel	Heavy heavy-duty diesel
2021–2023	CO_2 Standard (g/bhp-hr)	565	565	544
	Fuel Consumption Standard (gallon/100 bhp-hr)	5.5501	5.5501	5.3438
2024–2026	CO_2 Standard (g/bhp-hr)	556	556	536
	Fuel Consumption (gallon/100 bhp-hr)	5.4617	5.4617	5.2652
2027 and Later	CO_2 Standard (g/bhp-hr)	553	553	533
	Fuel Consumption (gallon/100 bhp-hr)	5.4322	5.4322	5.2358

Although both EPA and NHTSA are proposing to begin the Phase 2 engine standards, EPA considered proposing Phase 2 standards that would begin before MY 2021—that is with less lead time. NHTSA is required by statute to

gasoline-fueled engine or any other type of engine with a spark plug (or other sparking device) and with operating characteristics similar to the Otto combustion cycle. However, engines that meet the definition of spark-ignition per 1036.801, but are regulated as diesel engines under 40 CFR part 86 (for criteria pollutants) are treated as compression-ignition engines for GHG standards. Compression-ignition means relating to a type of reciprocating, internal-combustion engine that is not a spark-ignition engine, however, engines that meet the definition of compression-ignition per 1036.801, but are regulated as Otto-cycle engines under 40 CFR part 86 are treated as spark-ignition engines for GHG standards.

[103] The agencies note that the CO_2 and fuel consumption standards for Class 7 and 8 combination tractors do not cover gasoline or LHDD engines, as those are not used in Class 7 and 8 combination tractors.

[104] Tractor engine standards apply to all engines, without regard to the engine-cycle classification.

provide four models years of lead time, while EPA is required only to provide lead time ''necessary to permit the development and application of the requisite technology'' (CAA Section 202(a)(2)). However, as noted in Section I, lead time cannot be separated for other relevant factors such as costs, reliability, and stringency. Proposing these standards before 2021 could increase the risk of reliability issues in the early years. Given the limited number of engine models that each manufacturer produces, managing that many new standards would be problematic (*i.e.,* new Phase 1 standards in 2017, new Phase 2 EPA standards in 2018, 2019, or 2020, new standards in 2021, 2024, and again in 2027). Considering these challenges, EPA determined that earlier model year standards would not be appropriate, especially given the value of harmonizing the NHTSA and EPA standards.

(a) Feasibility of the Diesel (Compression-Ignition) Engine Standards

In this section, the agencies discuss our assessment of the feasibility of the proposed engine standards and the extent to which they would conform to our respective statutory authority and responsibilities. More details on the technologies discussed here can be found in the Draft RIA Chapter 2.3. The feasibility of these technologies is further discussed in draft RIA Chapter 2.7 for tractor and vocational vehicle engines. Note also, that the agencies are considering adopting engine standards with less lead time, and may do so in the Final Rules. These standards are discussed in Section (e).

Based on the technology analysis described below, the agencies can project a technology path exists to allow manufacturers to meet the proposed final Phase 2 standards by 2027, as well as meeting the intermediate 2021 and 2024 standards. The agencies also project that manufacturers would be able to meet these standards at a reasonable cost and without adverse impacts on in-use reliability. Note that the agencies are still evaluating whether these same standards could be met sooner, as was analyzed in Alternative 4.

In general, engine performance for CO_2 emissions and fuel consumption can be improved by improving combustion and reducing energy losses. More specifically, the agencies have identified the following key areas where fuel efficiency can be improved:

- Combustion optimization
- Turbocharging system
- Engine friction and other parasitic losses
- Exhaust aftertreatment
- Engine breathing system
- Engine downsizing
- Waste heat recovery
- Transient control for vocational engines only

The agencies are proposing to phase-in the standards from 2021 through 2027 so that manufacturers could gradually introduce these technologies. For most of these improvements, the agencies project manufacturers could begin applying them to about 45–50 percent of their heavy-duty engines by 2021, 90–95 percent by 2024, and ultimately apply them to 100 percent of their heavy-duty engines by 2027. However, for some of these improvements (such as waste heat recovery and engine downsizing) we project lower application rates in the Phase 2 time frame. This phase-in structure is consistent with the normal manner in which manufacturers introduce new technology to manage limited R&D budgets and well as to allow them to work with fleets to fully evaluate in-use reliability before a technology is applied fleet-wide. The agencies believe the proposed phase-in schedule would allow manufacturers to complete these normal processes. As described in Section (e), the agencies are also requesting comment on whether manufacturers could complete these development steps more quickly so that they could meet these standards sooner.

Based on our technology assessment described below, the proposed engine standards appear to be consistent with the agencies' respective statutory authorities. All of the technologies with high penetration rates above 50 percent have already been demonstrated to some extent in the field or in research laboratories, although some development work remains to be completed. We note that our feasibility analysis for these engine standards is not based on projecting 100 percent application for any technology until 2027. We believe that projecting less than 100 percent application is appropriate and gives us additional confidence that the interim standards would be feasible.

Because this analysis considers reductions from engines meeting the Phase 1 standards, it assumes manufacturers would continue to include the same compliance margins as Phase 1. In other words, a manufacturer currently declaring FCLs 10 g/hp-hr above its measured emission rates (in order to account for production and test-to-test variability) would continue to do the same in Phase 2. We request comment on this assumption.

The agencies have carefully considered the costs of applying these technologies, which are summarized in Section II.D.(2) (d). These costs appear to be reasonable on both a per engine basis, and when considering payback periods.[105] The engine technologies are discussed in more detail below. Readers are encouraged to see the draft RIA Chapter 2 for additional details (and underlying references) about our feasibility analysis.

(i) Combustion Optimization

Although manufacturers are making significant improvements in combustion to meet the Phase 1 engine standards, the agencies project that even more improvement would be possible after 2018. For example, improvements to fuel injection systems would allow more flexible fuel injection capability with higher injection pressure, which can provide more opportunities to improve engine fuel efficiency. Further optimization of piston bowls and injector tips would also improve engine performance and fuel efficiency. We project that a reduction of up to 1.0 percent is feasible in the 2024 model year through the use of these technologies, although it would likely apply to only 95 percent of engines until 2027.

Another important area of potential improvement is advanced engine control incorporating model based calibration to reduce losses of control during transient operation. Improvements in computing power and speed would make it possible to use much more sophisticated algorithms that are more predictive than today's controls. Because such controls are only beneficial during transient operation, they would reduce emission over the FTP cycle, and during in-use operation, they would not reduce emissions over the SET cycle. Thus the agencies are projecting model based control reductions only for vocational engines. Although this control concept is not currently available, we project model based controls achieving a 2 percent improvement in transient emissions could be in production for some engine models by 2021. By 2027, we project over one-third of all vocational diesel engines would incorporate model-based controls.

(ii) Turbocharging System

Many advanced turbocharger technologies can be potentially added

[105] See Section IX.M for additional information about payback periods.

into production in the time frame between 2021 and 2027, and some of them are already in production, such as mechanical or electric turbo-compound, more efficient variable geometry turbine, and Detroit Diesel's patented asymmetric turbocharger. A turbo compound system extracts energy from the exhaust to provide additional power. Mechanical turbo-compounding includes a power turbine located downstream of the turbine which in turn is connected to the crankshaft to supply additional power. On-highway demonstrations of this technology began in the early 1980s. It was used first in heavy duty production by Detroit Diesel for their DD15 and DD16 engines and reportedly provided a 3 to 5 percent fuel consumption reduction. Results are duty cycle dependent, and require significant time at high load to see a fuel efficiency improvement. Light load factor vehicles can expect little or no benefit. Volvo reports two to four percent fuel consumption improvement in line haul applications, which could be in production even by 2020.

(iii) Engine Friction and Parasitic Losses

The friction associated with each moving part in an engine results in a small loss of engine power. For example, frictional losses occur at bearings, in the valvetrain, and at the piston-cylinder interface. Taken together such losses represent a large fraction of all energy lost in an engine. For Phase 1, the agencies projected a 1–2 percent reduction in fuel consumption due to friction reduction. However, new information leads us to project that an additional 1.4 percent reduction would be possible for some engines by 2021 and all engines by 2027. These reductions would be possible due to improvements in bearing materials, lubricants, and new accessory designs such as variable-speed pumps.

(iv) Aftertreatment Optimization

All diesel engines manufacturers are already using diesel particulate filter (DPF) to reduce particulate matter (PM) and selective catalytic reduction (SCR) to reduce NO_X emissions. The agencies see two areas in which improved aftertreatment systems can also result in lower fuel consumption. First, increased SCR efficiency could allow re-optimization of combustion for better fuel consumption because the SCR would be capable of reducing higher engine-out NO_X emissions. Second, improved designs could reduce backpressure on the engine to lower pumping losses. The agencies project the combined impact of such improvements could be 0.6 percent or more.

(v) Engine Breathing System

Various high efficiency air handling (for both intake air and exhaust) processes could be produced in the 2020 and 2024 time frame. To maximize the efficiency of such processes, induction systems may be improved by manufacturing more efficiently designed flow paths (including those associated with air cleaners, chambers, conduit, mass air flow sensors and intake manifolds) and by designing such systems for improved thermal control. Improved turbocharging and air handling systems would likely include higher efficiency EGR systems and intercoolers that reduce frictional pressure loss while maximizing the ability to thermally control induction air and EGR. EGR systems that often rely upon an adverse pressure gradient (exhaust manifold pressures greater than intake manifold pressures) must be reconsidered and their adverse pressure gradients minimized. Other components that offer opportunities for improved flow efficiency include cylinder heads, ports and exhaust manifolds to further reduce pumping losses by about 1 percent.

(vi) Engine Downsizing

Proper sizing of an engine is an important component of optimizing a vehicle for best fuel consumption. This Phase 2 rule would improve overall vehicle efficiency, which would result in a drop in the vehicle power demand for most operation. This drop moves the vehicle operating points down to a lower load zone, which can move the engine away from the sweet spot. Engine downsizing combined with engine downspeeding can allow the engine to move back to higher loads and lower speed zone, thus achieving slightly better fuel economy in the real world. However, because of the way engines are tested, little of the benefit of engine downsizing would be detected during engine testing (if power density remains the same) because the engine test cycles are normalized based on the full torque curve. Thus the current engine test is not the best way to measure the true effectiveness of engine downsizing. Nevertheless, we project that some small benefit would be measured over the engine test cycles—perhaps up to a one-quarter percent improvement in fuel consumption. Note that a bigger benefit would be observed during GEM simulation, better reflecting real world improvements. This is factored into the vehicle standards. Thus, the agencies see no reason to fundamentally revise the engine test procedure at this time.

(vii) Waste Heat Recovery

More than 40 percent of all energy loss in an engine is lost as heat to the exhaust and engine coolant. For many years, manufacturers have been using turbochargers to convert some of the waste heat in the exhaust into usable mechanical power than is used to compress the intake air. Manufacturers have also been working to use a Rankine cycle-based system to extract additional heat energy from the engine. Such systems are often called waste heat recovery (WHR) systems. The possible sources of energy include the exhaust, recirculated exhaust gases, compressed charge air, and engine coolant. The basic approach with WHR is to use waste heat from one or more of these sources to evaporate a working fluid, which is passed through a turbine or equivalent expander to create mechanical or electrical power, then re-condensed.

Prior to the Phase 1 Final Rule, the NAS estimated the potential for WHR to reduce fuel consumption by up to 10 percent.[106] However, the agencies do not believe such levels would be achievable within the Phase 2 time frame. There currently are no commercially available WHR systems for diesel engines, although research prototype systems are being tested by some manufacturers. The agencies believe it is likely a commercially-viable WHR capable of reducing fuel consumption by over three percent would be available in the 2021 to 2024 time frame. Cost and complexity may remain high enough to limit the use of such systems in this time frame. Moreover, packaging constraints and transient response challenges would limit the application of WHR systems to line-haul tractors. Refer to RIA Chapter 2 for a detailed description of these systems and their applicability. The agencies project that WHR recovery could be used on 1 percent of all tractor engines by 2021, on 5 percent by 2024, and 15 percent by 2027.

The net cost and effectiveness of future WHR systems would depend on the sources of waste heat. Systems that extract heat from EGR gases may provide the side benefit of reducing the size of EGR coolers or eliminating them altogether. To the extent that WHR systems use exhaust heat, they would increase the overall cooling system heat rejection requirement and likely require larger radiators. This could have negative impacts on cooling fan power

[106] *See* 2010 NAS Report, page 57.

needs and vehicle aerodynamics. Limited engine compartment space under hood could leave insufficient room for additional radiator size increasing. On the other hand, WHR systems that extract heat from the engine coolant, could actually improve overall cooling.

(viii) Technology Packages for Diesel Engines Installed in Tractors

Typical technology packaged for diesel engines installed in tractors basically includes most technologies mentioned above, which includes combustion optimization, turbocharging system, engine friction and other parasitic losses, exhaust aftertreatment, engine breathing system, and engine downsizing. Depending on the technology maturity of WHR and market demands, a small number of tractors could install waste heat recovery device with Rankine cycle technology. During the stringency development, the agencies received strong support from various stakeholders, where they graciously provided many confidential business information (CBI) including both technology reduction potentials and estimated market penetrations. Combining those CBI data with the agencies' engineering judgment, Table II–4 lists those potential technologies together with the agencies' estimated market penetration for tractor engine. Those reduction values shown as ''SET reduction'' are relative to Phase 1 engine, which is shown in Table II–6. It should be pointed out that the stringency in Table II–6 are developed based on the proposed SET reweighting factors l shown in Table II–2. The agencies welcome comment on the market penetration rates listed below.

TABLE II–6—PROJECTED TRACTOR ENGINE TECHNOLOGIES AND REDUCTION

SET mode	SET weighted reduction (%) 2020–2027	Market penetration (2021) %	Market penetration (2024) %	Market penetration (2027) %
Turbo compound with clutch	1.8	5	10	10
WHR (Rankine cycle)	3.6	1	5	15
Parasitic/Friction (Cyl Kits, pumps, FIE), lubrication	1.4	45	95	100
Aftertreatment (lower dP)	0.6	45	95	100
EGR/Intake & exhaust manifolds/Turbo/VVT/Ports	1.1	45	95	100
Combustion/FI/Control	1.1	45	95	100
Downsizing	0.3	10	20	30
Weighted reduction (%)	....	1.5	3.7	4.2

(ix) Technology Packages for Diesel Engines Installed in Vocational Vehicles

For compression-ignition engines fitted into vocational vehicles, the agencies are proposing MY 2021 standards that would require engine manufacturers to achieve, on average, a 2.0 percent reduction in fuel consumption and CO_2 emissions beyond the baseline that is the Phase 1 standard. Beginning in MY 2024, the agencies are proposing engine standards that would require diesel engine manufacturers to achieve, on average, a 3.5 percent reduction in fuel consumption and CO_2 emissions beyond the Phase 1 baseline standards for all diesel engines including LHD, MHD, and HHD. The agencies are proposing these standards based on the performance of reduced parasitics and friction, improved aftertreatment, combustion optimization, superchargers with VGT and bypass, model-based controls, improved EGR cooling/transport, and variable valve timing (only in LHD and MHD engines). The percent reduction for the MY2021, MY2024, and MY2027 standards is based on the combination of technology effectiveness and market adoption rate projected.

Most of the potential engine related technologies discussed previously can be applied here. However, neither the waste heat technologies with the Rankine cycle concept nor turbo-compound would be applied into vocational sector due to the inefficient use of waste heat energy with duty cycles and applications with more transient operation than highway operation. Given the projected cost and complexity of such systems, we believe that for the Phase 2 time frame manufacturers will focus their development work on tractor applications (which would have better payback for operators) rather than vocational applications. In addition, the benefits due to engine downsizing, which can be seen in tractor engines, may not be clearly seen in vocational sector, again because this control technology produces few benefits in transient operation.

One of the most effective technologies for vocational engines is the optimization of transient control. It would be expected that more advanced transient control including different levels of model based control and neural network control package could provide substantial benefits in vocational engines due to the extensive transient operation of these vehicles. For this technology, the use of the FTP cycle would drive engine manufacturers to invest more in transient control to improve engine efficiency. Other effective technologies would be parasitic/friction reduction, as well as improvements to combustion, air handling systems, turbochargers, and aftertreatment systems. Table II–7 below lists those potential technologies together with the agencies' projected market penetration for vocational engines. Again, similar to tractor engine, the technology reduction and market penetration are estimated by combining the CBI data together with the agencies' engineering judgment. Those reduction values shown as ''FTP reduction'' are relative to a Phase 2 baseline engine, which is shown in Table II–3. The weighted reductions combine the emission reduction values weighted by the market penetration of each technology).

TABLE II–7—PROJECTED VOCATIONAL ENGINE TECHNOLOGIES AND REDUCTION

Technology	GHG emissions reduction 2020–2027 %	Market penetration 2021 %	Market penetration 2024 %	Market penetration 2027 %
Model based control	2.0	25	30	40
Parasitic/Friction	1.5	60	90	100
EGR/Air/VVT/Turbo	1.0	50	90	100
Improved AT	0.5	50	90	100
Combustion Optimization	1.0	50	90	100
Weighted reduction (%)–L/M/HHD		2.0	3.5	4.0

(x) Summary of the Agencies' Analysis of the Feasibility of the Proposed Diesel Engine Standards

The proposed HD Phase 2 standards are based on adoption rates for technologies that the agencies regard, subject to consideration of public comment, as the maximum feasible for purposes of EISA Section 32902(k) and appropriate under CAA Section 202(a) for the reasons given above. The agencies believe these technologies can be adopted at the estimated rates for these standards within the lead time provided, as discussed in draft RIA Chapter 2. The 2021 and 2024 MY standards are phase-in standards on the path to the 2027 MY standards and were developed using less aggressive application rates and therefore have lower technology package costs than the 2027 MY standards.

As described in Section II.D.(2)(d) below, the cost of the proposed standards is estimated to range from $270 to $1,698 per engine. This is slightly higher than the costs for Phase 1, which were estimated to be $234 to $1,091 per engine. Although the agencies did not separately determine fuel savings or emission reductions due to the engine standards apart from the vehicle program, it is expected that the fuel savings would be significantly larger than these costs, and the emission reductions would be roughly proportional to the technology costs when compared to the corresponding vehicle program reductions and costs. Thus, we regard these standards as cost-effective. This is true even without considering payback period. The proposed phase-in 2021 and 2024 MY standards are less stringent and less costly than the proposed 2027 MY standards. Given that the agencies believe the proposed standards are technologically feasible, are highly cost effective, and highly cost effective when accounting for the fuel savings, and have no apparent adverse potential impacts (*e.g.,* there are no projected negative impacts on safety or vehicle utility), the proposed standards appear to represent a reasonable choice under Section 202(a) of the CAA and the maximum feasible under NHTSA's EISA authority at 49 U.S.C. 32902(k)(2).

(b) Basis for Continuing the Phase 1 Spark-Ignited Engine Standard

Today most SI-powered vocational vehicles are sold as incomplete vehicles by a vertically integrated chassis manufacturer, where the incomplete chassis shares most of the same technology as equivalent complete pickups or vans, including the powertrain. The number of such incomplete SI-powered vehicles is small compared to the number of completes. Another, even less common way that SI-powered vocational vehicles are built is by a non-integrated chassis manufacturer purchasing an engine from a company that also produces complete and/or incomplete HD pickup trucks and vans. The resulting market structure leads manufacturers of heavy-duty SI engines to have little market incentive to develop separate technology for vocational engines that are engine-certified. Moreover, the agencies have not identified a single SI engine technology that we believe belongs on engine-certified vocational engines that we do not also project to be used on complete heavy-duty pickups and vans.

In light of this market structure, when the agencies considered the feasibility of more stringent Phase 2 standards for SI vocational engines, we identified the following key questions:

1. Will there be technologies available that could reduce in-use emissions from vocational SI engines?

2. Would these technologies be applied to complete vehicles and carried-over to engine certified engines without a new standard?

3. Would these technologies be applied to meet the vehicle-based standards described in Section V?

4. What are the drawbacks associated with setting a technology-forcing Phase 2 standard for SI engines?

With respect to the first and second questions, as noted in Chapter 2.6 of the draft RIA, the agencies have identified improved lubricants, friction reduction, and cylinder deactivation as technologies that could potentially reduce in-use emissions from vocational engines; and the agencies have further determined that to the extent these technologies would be viable for complete vehicles, they would also be applied to engine-certified engines. Nevertheless, significant uncertainty remains about how much benefit would be provided by these technologies. It is possible that the combined impact of these technologies would be one percent or less. With respect to the third question, we believe that to the extent these technologies are viable and effective, they would be applied to meet the vehicle-based standards for vocational vehicles.

At this time, it appears the fourth question regarding drawbacks is the most important. The agencies could propose a technology forcing standard for vocational SI engines based on a projection of each of these technologies being effective for these engines. However, as already noted in Section I, the agencies see value in setting the standards at levels that would not require every projected technology to work as projected. Effectively requiring technologies to match our current projections would create the risk that the standards would not be feasible if even a single one of technologies failed to match our projections. This risk is amplified for SI engines because of the very limited product offerings, which provide far fewer opportunities for averaging than exist for CI engines. Given the relatively small improvement projected, and the likelihood that most or all of this improvement would result anyway from the complete pickup and van standards and the vocational vehicle-based standards, we do not believe such risk is justified or needed. The approach the agencies are proposing accomplishes the same objective without the attendant potential risk. With this approach, the Phase 1 SI engine standard for these engines would remain in place, and engine improvements would be reflected in the stringency of the vehicle standard for the vehicle in which the engine would be installed. Nevertheless, we request comment on the merits of adopting a more stringent SI engine standard in the 2024 to 2027 time frame, including comment on technologies, adoption rates, and effectiveness over the engine cycle that could support adoption of a more stringent standard. Please see Section V.C of this preamble for a description of the SI engine technologies that have been considered in developing the proposed vocational vehicle standards. Please see Section VI.C of this preamble for a description of the SI engine technologies that have been considered in developing the proposed HD pickup truck and van standards.

(c) Engine Improvements Projected for Vehicles over the GEM Duty Cycles

Because we are proposing that tractor and vocational vehicle manufacturers represent their vehicles' actual engines in GEM for vehicle certification, the agencies aligned our *engine* technology effectiveness assessments for both the separate engine standards and the tractor and vocational vehicle standards for each of the regulatory alternatives considered. This was an important step because we are proposing to recognize the same engine technologies in both the separate engine standards and the vehicle standards, which each have different test procedures for demonstrating compliance. As explained earlier in Section II. D. (1), compliance with the tractor separate engine standards is determined from a composite of the Supplemental Engine Test (SET) procedure's 13 steady-state operating points. Compliance with the vocational vehicle separate engine standards is determined over the Federal Test Procedure's (FTP) transient engine duty cycle. In contrast, compliance with the vehicle standards is determined using GEM, which calculates composite results over a combination of 55 mph and 65 mph steady-state vehicle cycles and the ARB Transient vehicle cycle. Note that we are also proposing a new workday idle cycle for vocational vehicles. Each of these duty cycles emphasizes different engine operating points; therefore, they can each recognize certain technologies differently.

Our first step in aligning our engine technology assessment at both the engine and vehicle levels was to start with an analysis of how we project each technology to impact performance at each of the 13 individual test points of the SET steady-state engine duty cycle. For example, engine friction reduction technology would be expected to have the greatest impact at the highest engine speeds, where frictional energy losses are the greatest. As another example, turbocharger technology is generally optimized for best efficiency at steady-state cruise vehicle speed. For an engine this is near its lower peak-torque speed and at a moderately high load that still offers sufficient torque reserve to climb modest road grades without frequent transmission gear shifting. The agencies also considered the combination of certain technologies causing synergies and dis-synergies with respect to engine efficiency at each of these test points. See RIA Chapter 2 for further details.

Next we estimated unique brake-specific fuel consumption values for each of the 13 SET test points for two hypothetical MY2018 tractor engines that would be compliant with the Phase 1 standards. These were a 15 liter displacement 455 horsepower engine and an 11 liter 350 horsepower engine. We then added technologies to these engines that we determined were feasible for MY2021, MY2024, and MY 2027, and we determined unique improvements at each of the 13 SET points. We then calculated composite SET values for these hypothetical engines and determined the SET improvements that we could use to propose more stringent separate tractor engine standards for MY2021, MY2024, and MY 2027.

To align our engine technology analysis for vehicles to the SET engine analysis described above, we then fit a surface equation through each engine's SET points versus engine speed and load to approximate their analogous fuel maps that would represent these same engines in GEM. Because the 13 SET test points do not fully cover an engine's wide range of possible operation, we also determined improvements for an additional 6 points of engine operation to improve the creation of GEM fuel maps for these engines. Then for each of these 8 tractor engines (two each for MY2018, MY2021, MY2024, and MY2027) we ran GEM simulations to represent low-, mid-, and high-roof sleeper cabs and low-, mid-, and high-roof day cabs. Class 8 tractors were assumed for the 455 horsepower engine and Class 7 tractors (day cabs only) were assumed for the 350 horsepower engine. Each GEM simulation calculated results for the 55 mph, 65 mph, and ARB Transient cycles, as well as the composite GEM value associated with each of the tractor types. After factoring in our Alternative 3 projected market penetrations of the engine technologies, we then compared the percent improvements that the same sets of engine technology caused over the separate engines' SET composites and the various vehicles' GEM composites. Compared to their respective MY2018 baseline engines, the two engines of different horsepower showed the same percent improvements. All of the tractor cab types showed nearly the same relative improvements too. For example, for the MY2021 Alternative 3 engine technology package in a high roof sleeper tractor, the SET engine composites showed a 1.5 percent improvement and the GEM composites a 1.6 percent improvement. For the MY2024 Alternative 3 engine technology packages, the SET engine composites showed a 3.7 percent improvement and the GEM composites a 3.7 percent improvement. For MY2027 Alternative 3 engine technology packages, the SET engine composites showed a 4.2 percent improvement and the GEM composites a 4.2 percent improvement. We therefore concluded that tractor engine technologies will improve engines and tractors proportionally, even though the separate engine and vehicle certification test procedures have different duty cycles.

We then repeated this same process for the FTP engine transient cycle and the GEM vocational vehicle types. For the vocational engine analysis we investigated four engines: 15 liter displacement engine at 455 horsepower rating, 11 liter displacement engine at 345 horsepower rating, a 7 liter displacement engine at a 200 horsepower rating and a 270 horsepower rating. These engines were then used in GEM over the light-heavy, medium-heavy, and heavy-heavy vocational vehicle configurations. Because the technologies were assumed to impact each point of the FTP in the same way, the results for all engines and vehicles were 2.0 percent improvement in MY2021, 3.5 percent improvement in MY2024, and 4.0 percent improvement in MY2027. Therefore, we arrived at the same conclusion that vocational vehicle engine technologies are recognized at the same percent improvement over the FTP as the GEM cycles. We request comment on our approach to arrive at this conclusion.

(d) Engine Technology Package Costs for Tractor and Vocational Engines (and Vehicles)

As described in Chapters 2 and 7 of the draft RIA, the agencies estimated costs for each of the engines technologies discussed here. All costs are presented relative to engines projected to comply with the model year 2017 standards—*i.e.,* relative to our baseline engines. Note that we are not presenting any costs for gasoline engines (SI engines) because we are not proposing to change the standards.

Our engine cost estimates include a separate analysis of the incremental part costs, research and development activities, and additional equipment. Our general approach used elsewhere in this action (for HD pickup trucks, gasoline engines, Class 7 and 8 tractors, and Class 2b-8 vocational vehicles) estimates a direct manufacturing cost for a part and marks it up based on a factor to account for indirect costs. *See also* 75 FR 25376. We believe that approach is appropriate when compliance with proposed standards is achieved generally by installing new parts and systems purchased from a supplier. In such a case, the supplier is conducting the bulk of the research and development on the new parts and systems and including those costs in the purchase price paid by the original equipment manufacturer. The indirect costs incurred by the original equipment manufacturer need not include much cost to cover research and development since the bulk of that effort is already done. For the MHD and HHD diesel engine segment, however, the agencies believe that OEMs will incur costs not associated with the purchase of parts or systems from suppliers or even the production of the parts and systems, but rather the development of the new technology by the original equipment manufacturer itself. Therefore, the agencies have directly estimated additional indirect costs to account for these development costs. The agencies used the same approach in the Phase 1 HD rule. EPA commonly uses this approach in cases where significant investments in research and development can lead to an emission control approach that requires no new hardware. For example, combustion optimization may significantly reduce emissions and cost a manufacturer millions of dollars to develop but would lead to an engine that is no more expensive to produce. Using a bill of materials approach would suggest that the cost of the emissions control was zero reflecting no new hardware and ignoring the millions of dollars spent to develop the improved combustion system. Details of the cost analysis are included in the draft RIA Chapter 2. To reiterate, we have used this different approach because the MHD and HHD diesel engines are expected to comply in part via technology changes that are not reflected in new hardware but rather reflect knowledge gained through laboratory and real world testing that allows for improvements in control system calibrations—changes that are more difficult to reflect through direct costs with indirect cost multipliers. Note that these engines are also expected to incur new hardware costs as shown in Table II–8 through Table II–11. EPA also developed the incremental piece cost for the components to meet each of the 2021 and 2024 standards. The costs shown in Table II–12 include a low complexity ICM of 1.15 and assume the flat-portion of the learning curve is applicable to each technology.

(i) Tractor Engine Package Costs

TABLE II–8—PROPOSED MY2021 TRACTOR DIESEL ENGINE COMPONENT COSTS INCLUSIVE OF INDIRECT COST MARKUPS AND ADOPTION RATES (2012$)

	Medium HD	Heavy HD
Aftertreatment system (improved effectiveness SCR, dosing, DPF)	$7	$7
Valve Actuation	82	82
Cylinder Head (flow optimized, increased firing pressure, improved thermal management)	3	3
Turbocharger (improved efficiency)	9	9
Turbo Compounding	50	50
EGR Cooler (improved efficiency)	2	2
Water Pump (optimized, variable vane, variable speed)	43	43
Oil Pump (optimized)	2	2
Fuel Pump (higher working pressure, increased efficiency, improved pressure regulation)	2	2
Fuel Rail (higher working pressure)	5	5
Fuel Injector (optimized, improved multiple event control, higher working pressure)	5	5
Piston (reduced friction skirt, ring and pin)	1	1
Valvetrain (reduced friction, roller tappet)	39	39
Waste Heat Recovery	105	105
"Right sized" engine	−40	−40
Total	314	314

Note: "Right sized" diesel engine is a smaller, less costly engine than the engine it replaces.

TABLE II–9—PROPOSED MY2024 TRACTOR DIESEL ENGINE COMPONENT COSTS INCLUSIVE OF INDIRECT COST MARKUPS AND ADOPTION RATES (2012$)

	Medium HD	Heavy HD
Aftertreatment system (improved effectiveness SCR, dosing, DPF)	$14	$14
Valve Actuation	166	166
Cylinder Head (flow optimized, increased firing pressure, improved thermal management)	6	6
Turbocharger (improved efficiency)	17	17
Turbo Compounding	92	92
EGR Cooler (improved efficiency)	3	3
Water Pump (optimized, variable vane, variable speed)	84	84
Oil Pump (optimized)	4	4
Fuel Pump (higher working pressure, increased efficiency, improved pressure regulation)	4	4
Fuel Rail (higher working pressure)	9	9
Fuel Injector (optimized, improved multiple event control, higher working pressure)	10	10
Piston (reduced friction skirt, ring and pin)	3	3
Valvetrain (reduced friction, roller tappet)	75	75

TABLE II–9—PROPOSED MY2024 TRACTOR DIESEL ENGINE COMPONENT COSTS INCLUSIVE OF INDIRECT COST MARKUPS AND ADOPTION RATES (2012$)—Continued

	Medium HD	Heavy HD
Waste Heat Recovery	502	502
"Right sized" engine	−85	−85
Total	904	904

Note: "Right sized" diesel engine is a smaller, less costly engine than the engine it replaces.

TABLE II–10—PROPOSED MY2027 TRACTOR DIESEL ENGINE COMPONENT COSTS INCLUSIVE OF INDIRECT COST MARKUPS AND ADOPTION RATES (2012$)

	Medium HD	Heavy HD
Aftertreatment system (improved effectiveness SCR, dosing, DPF)	$14	$14
Valve Actuation	169	169
Cylinder Head (flow optimized, increased firing pressure, improved thermal management)	6	6
Turbocharger (improved efficiency)	17	17
Turbo Compounding	87	87
EGR Cooler (improved efficiency)	3	3
Water Pump (optimized, variable vane, variable speed)	84	84
Oil Pump (optimized)	4	4
Fuel Pump (higher working pressure, increased efficiency, improved pressure regulation)	4	4
Fuel Rail (higher working pressure)	9	9
Fuel Injector (optimized, improved multiple event control, higher working pressure)	10	10
Piston (reduced friction skirt, ring and pin)	3	3
Valvetrain (reduced friction, roller tappet)	75	75
Waste Heat Recovery	1,340	1,340
"Right sized" engine	−127	−127
Total	1,698	1,698

Note: "Right sized" diesel engine is a smaller, less costly engine than the engine it replaces.

(ii) Vocational Diesel Engine Package Costs

TABLE II–11—PROPOSED MY2021 VOCATIONAL DIESEL ENGINE COMPONENT COSTS INCLUSIVE OF INDIRECT COST MARKUPS AND ADOPTION RATES (2012$)

	Light HD	Medium HD	Heavy HD
Aftertreatment system (improved effectiveness SCR, dosing, DPF)	$8	$8	$8
Valve Actuation	91	91	91
Cylinder Head (flow optimized, increased firing pressure, improved thermal management)	6	3	3
Turbocharger (improved efficiency)	10	10	10
EGR Cooler (improved efficiency)	2	2	2
Water Pump (optimized, variable vane, variable speed)	57	57	57
Oil Pump (optimized)	3	3	3
Fuel Pump (higher working pressure, increased efficiency, improved pressure regulation)	3	3	3
Fuel Rail (higher working pressure)	7	6	6
Fuel Injector (optimized, improved multiple event control, higher working pressure)	8	6	6
Piston (reduced friction skirt, ring and pin)	1	1	1
Valvetrain (reduced friction, roller tappet)	69	52	52
Model Based Controls	28	28	28
Total	293	270	270

TABLE II–12—PROPOSED MY2024 VOCATIONAL DIESEL ENGINE COMPONENT COSTS INCLUSIVE OF INDIRECT COST MARKUPS AND ADOPTION RATES (2012$)

	Light HD	Medium HD	Heavy HD
Aftertreatment system (improved effectiveness SCR, dosing, DPF)	$13	$13	$13
Valve Actuation	157	157	157
Cylinder Head (flow optimized, increased firing pressure, improved thermal management)	10	6	6
Turbocharger (improved efficiency)	16	16	16
EGR Cooler (improved efficiency)	3	3	3
Water Pump (optimized, variable vane, variable speed)	79	79	79
Oil Pump (optimized)	4	4	4

TABLE II–12—PROPOSED MY2024 VOCATIONAL DIESEL ENGINE COMPONENT COSTS INCLUSIVE OF INDIRECT COST MARKUPS AND ADOPTION RATES (2012$)—Continued

	Light HD	Medium HD	Heavy HD
Fuel Pump (higher working pressure, increased efficiency, improved pressure regulation)	4	4	4
Fuel Rail (higher working pressure)	10	9	9
Fuel Injector (optimized, improved multiple event control, higher working pressure)	13	10	10
Piston (reduced friction skirt, ring and pin)	2	2	2
Valvetrain (reduced friction, roller tappet)	95	71	71
Model Based Controls	31	31	31
Total	437	405	405

TABLE II–13—PROPOSED MY2027 VOCATIONAL DIESEL ENGINE COMPONENT COSTS INCLUSIVE OF INDIRECT COST MARKUPS AND ADOPTION RATES (2012$)

	Light HD	Medium HD	Heavy HD
Aftertreatment system (improved effectiveness SCR, dosing, DPF)	$14	$14	$14
Valve Actuation	169	169	169
Cylinder Head (flow optimized, increased firing pressure, improved thermal management)	10	6	6
Turbocharger (improved efficiency)	17	17	17
EGR Cooler (improved efficiency)	3	3	3
Water Pump (optimized, variable vane, variable speed)	84	84	84
Oil Pump (optimized)	4	4	4
Fuel Pump (higher working pressure, increased efficiency, improved pressure regulation)	4	4	4
Fuel Rail (higher working pressure)	11	9	9
Fuel Injector (optimized, improved multiple event control, higher working pressure)	13	10	10
Piston (reduced friction skirt, ring and pin)	3	3	3
Valvetrain (reduced friction, roller tappet)	100	75	75
Model Based Controls	39	39	39
Total	471	437	437

(e) Feasibility of Phasing In the CO_2 and Fuel Consumption Standards Sooner

The agencies are requesting comment on accelerated standards for diesel engines that would achieve the same reductions as the proposed standards, but with less lead time. Table II–14 and Table II–15 below show a technology path that the agencies project could be used to achieve the reductions that would be required within the lead time allowed by the alternative standards. As discussed in Sections I and X, the agencies are proposing to fully phase in these standards through 2027. The agencies believe that standards that fully phase in through 2024 have the potential to be the maximum feasible and appropriate option. However, based on the evidence currently before the agencies, we have outstanding questions (for which we are seeking comment) regarding relative risks and benefits of that option in the timeframe envisioned. Commenters are encouraged to address how technologies could develop if a shorter lead time is selected. In particular, we request comment on the likelihood that WHR systems would be available for tractor engines in this time frame, and that WHR systems would achieve the projected level of reduction and the necessary reliability. We also request comment on whether it would be possible to apply the model based controls described in Section II.D.(2)(a)(i) to this many vocational engines in this time frame.

TABLE II–14—PROJECTED TRACTOR ENGINE TECHNOLOGIES AND REDUCTION FOR ALTERNATIVE 4 STANDARDS

%-Improvements beyond Phase 1, 2018 engine as baseline	SET reduction (%)	Market penetration MY 2021 (%)	Market penetration MY 2024 (%)
Turbo compound	1.82	5	10
WHR (Rankine cycle)	3.58	4	15
Parasitics/Friction (Cyl Kits, pumps, FIE), lubrication	1.41	60	100
Aftertreatment	0.61	60	100
Exhaust Manifold Turbo Efficiency EGR Cooler VVT	1.14	60	100
Combustion/FI/Control	1.11	60	100
Downsizing	0.29	20	30
Market Penetration Weighted Package		2.1	4.2

TABLE II–15—PROJECTED VOCATIONAL ENGINE TECHNOLOGIES AND REDUCTION FOR MORE STRINGENT ALTERNATIVE STANDARDS

%-Improvements beyond Phase 1, 2018 engine as baseline	FTP reduction (%)	Market penetration MY 2021 (%)	Market penetration MY 2024 (%)
Model based control	2	30	40
Parasitics/Friction	1.5	70	100
EGR/Air/VVT/Turbo	1	70	100
Improved AT	0.5	70	100
Combustion Optimization	1	70	100
Weighted reduction (%)-L/MHD/HHD	....	2.5	4.0

The projected HDD engine package costs for both tractors and vocational engines in MYs 2021 and 2024 under Alternative 4 are shown in Table II–16. Note that, while the technology application rates in MY2024 under Alternative 4 are essentially identical to those for MY2027 under the proposal, the costs are about 5 to 11 percent higher under Alternative 4 due to learning effects and markup changes that are estimated to have occurred by MY2027 under Alternative 3. Note also that the agencies did not include any additional costs for accelerating technology development or to address potential in-use durability issues. We request comment on whether such costs would occur if we finalized this alternative. We also request comment on what steps could be taken to mitigate such costs.

TABLE II–16—EXPECTED PACKAGE COSTS FOR HD DIESEL ENGINES UNDER ALTERNATIVE 4 (2012$) [a]

Model year	MHDD tractor	HHDD tractor	LHDD voca- tional	MHDD voca- tional	HHDD voca- tional
2021	$656	$656	$372	$345	$345
2024	1,885	1,885	493	457	457

Note:
[a] Costs presented here include application rates.

The agencies' analysis shows that, in the absence of additional costs for accelerating technology development or to address potential in-use durability issues, the costs associated with Alternative 4 would be very similar to those we project for the proposed standards. Alternative 4 would also have similar payback times and cost-effectiveness. In other words, Alternative 4 would achieve some additional reductions for model years 2021 through 2026, with roughly proportional additional costs unless there were additional costs for accelerating development or for in-use durability issues. (Note that reductions and costs for MY 2027 and later would be equivalent for Alternative 4 and the proposed standards). In order to help make this assessment, we request comment on the following issues: whether manufacturers could meet these standards with three years less lead time, what additional expenses would be incurred to meet these standards with less lead time, and how reliable would the engines be if the manufacturers had to bring them to market three years earlier.

(3) Proposed EPA Engine Standards for N_2O

EPA is proposing to adopt the MY 2021 N_2O engine standards that were originally proposed for Phase 1. The proposed level for Phase 2 would be 0.05 g/hp-hr with a default deterioration factor of 0.01 g/hp-hr, which we believe is technologically feasible because a number of engines meet this level today. This level of stringency is consistent with the agency's Phase 1 approach to set ''cap'' standards for N_2O. EPA finalized Phase 1 standards for N_2O as engine-based standards at 0.10 g/hp-hr and a 0.02 g/hp-hr default deterioration factor because the agency believes that emissions of this GHG are technologically related solely to the engine, fuel, and emissions aftertreatment systems, and the agency is not aware of any influence of vehicle-based technologies on these emissions. We continue to believe this approach is appropriate, but we believe that more stringent standards are appropriate to ensure that N_2O emissions do not increase in the future. Note that NHTSA did not adopt standards for N_2O because these emissions do not impact fuel consumption in a significant way, and is not proposing such standards for Phase 2 for the same reason.

We are proposing this change at no additional cost and no additional benefit because manufacturers are generally meeting the proposed standard today. The purpose of this standard is to prevent increases in N_2O emissions absent this proposed increase in stringency. We request comment on whether or not we should be considering additional costs for compliance. Similarly, we request comment on whether or not we should assume N_2O increases in our ''No Action'' regulatory Alternatives 1a and 1b described in Section X.

Although N_2O is emitted in very small amounts, it can have a very significant impact on the climate. The global warming potential (GWP) of one molecule of N_2O is 298 times that of one molecule CO_2. Because N_2O and CO_2 coincidentally have the same molar mass, this means that one gram of N_2O would have the same impact on the climate as 298 grams of CO_2. To further put this into perspective, the difference between the proposed N_2O standard (and deterioration factor) and the current Phase 1 standard is 0.40 g/hp-hr of N_2O emissions. This is equivalent to 11.92 g/hp-hr CO_2. Over the same certification test cycle (*i.e.* EPA's HD FTP) the Phase 1 engine CO_2 emissions standard ranges from 460 to 576 g/hp-hr, depending on the service class of the engine. Therefore, absent today's proposed action, engine N_2O increases equivalent to 2.1 to 2.6 percent of the Phase 1 CO_2 standard could occur.

We are proposing this lower cap because we have determined that manufacturers generally are meeting this level today but in the future could increase N_2O emissions up to the current Phase 1 cap standard. Because we do not believe any manufacturer would need to do anything more than recalibrate their SCR systems to comply, the lead time being provided would be sufficient. This section later describes why manufacturers may increase N_2O emissions from SCR-equipped compression-ignition engines in the absence of a lower N_2O cap standard. We request comment on this. We also note that, as described in Section XI, EPA does not believe there is a similar opportunity to lower the pickup and van N_2O standard because it was set at a more stringent level in Phase 1.

(a) N_2O Formation

N_2O formation in modern diesel engines is a by-product of the SCR process. It is dependent on the SCR catalyst type, the NO_2 to NO_X ratio, the level of NO_X reduction required, and the concentration of the reactants in the system (NH_3 to NO_X ratio).

Two current engine/aftertreatment designs are driving N_2O emission higher. The first is an increase in engine out NO_X, which puts a higher NO_X reduction burden on the SCR NO_X emission control system. The second is an increase in NO_2 formation from the diesel oxidation catalyst (DOC) located upstream of the passive catalyzed diesel particulate filter (CDPF). This increase in NO_2 serves two functions: Improving passive CDPF regeneration and optimization of faster SCR reaction.[107]

There are multiple mechanisms through which N_2O can form in an SCR system:

1. Low temperature formation of N_2O over the DOC prior to the SCR catalyst.
2. Low temperature formation of NH_4NO_3 with subsequent decomposition as exhaust temperatures increase, leading to conversion to N_2O over the SCR catalyst.
3. Formation of N_2O from NO_2 over the SCR catalyst at NO_2 to NO ratios greater than 1:1. N_2O formation increases significantly at 300 to 350 °C.
4. Formation of N_2O from NH_3 via partial oxidation over the ammonia slip catalyst.
5. High-temperature N_2O formation over the SCR catalyst due to NH_3 oxidation facilitated by high SCR catalyst surface coverage of NH_3.

Thus, as discussed below, control of N_2O formation requires precise optimization of SCR controls including thermal management and dosing rates, as well as catalyst composition.

(b) N_2O Emission Reduction

Through on-engine and reactor bench experiments, this same work showed that the key to reducing N_2O emissions lies in intelligent emission control system design and operation, namely:

1. Selecting the appropriate DOC and/or CDPF catalyst loadings to maintain NO_2 to NO ratios at or below 1:1.
2. Avoiding high catalyst surface coverage of NH_3 though urea dosing management when the system is in the ideal N_2O formation window.
3. Utilizing thermal management to push the SCR inlet temperature outside of the N_2O low-temperature formation window.

EPA believes that reducing the standard from 0.1 g/hp-hr to 0.05 g/hp-hr is feasible because most engines have emission rates that would meet this standard today and the others could meet it with minor calibration changes at no additional cost. Numerous studies have shown that diesel engine technologies can be fine-tuned to meet the current NO_X and proposed N_2O standards while still providing passive CDPF regeneration even with earlier generations of SCR systems. Currently model year 2014 systems have already moved on to newer generation systems in which the combined CDPF and SCR functions have been further optimized. The result of this is 18 of 24 engines in the EPA 2014 certification database emitting N_2O at less than half of the 2014 standard, and thus below the proposed standard.[108] Given the discussions in the literature, there are still additional calibration steps that can be taken to further reduce N_2O emissions for the higher emitters to afford an adequate compliance margin and room to account for deterioration, without having an adverse effect on criteria pollutant emissions.

[107] Hallstrom, K., Voss, K., and Shah, S., ''The Formation of N_2O on the SCR Catalyst in a Heavy Duty US 2010 Emission Control System'', SAE Technical Paper 2013–01–2463.

[108] *http://www.epa.gov/otaq/crttst.htm.*

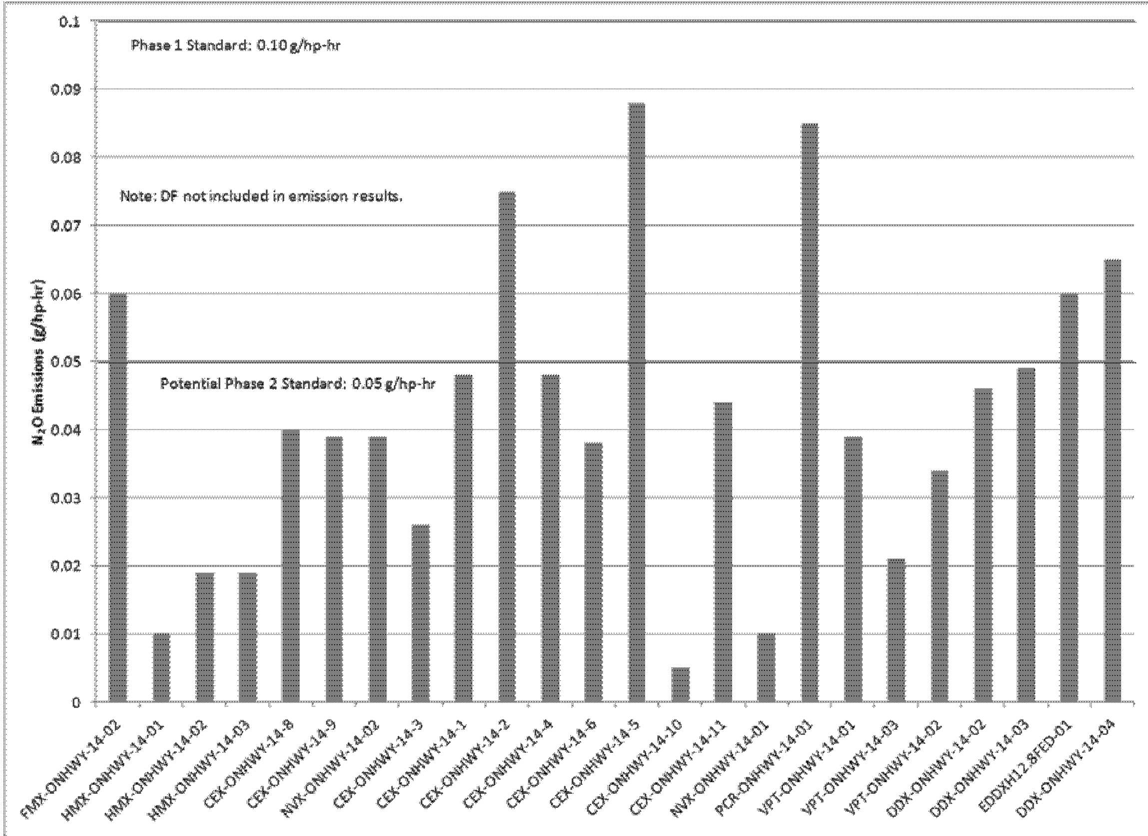

Figure II-2 EPA 2014 Certification Database N_2O Emission Results for 24 Engines

It is important to note, however, that there is a trade off when trying to optimize SCR systems to achieve peak NO_X reduction efficiencies. When transitioning from a <93 percent efficient MY 2011 system to a 98 percent efficient system of the future, lowering the N_2O cap to 0.05 g/hp-hr would put constraints on the techniques that can be applied to improve efficiency. If system designers push the NH_3 to NO_X ratio higher to try and achieve the maximum possible NO_X reduction, it could increase N_2O emissions. If EPA were to adopt a very low NO_X standard (*e.g.,* 0.02 g/hp-hr) over existing test cycles, some reductions would be needed throughout the hot portion of the cycle (although most of the reductions would have to come from the cold start portion of the test cycle). Thermal management would need to play a key role, and reducing catalyst light-off time would move the SCR catalyst through the ammonium nitrate formation and decomposition thermal range quicker, thus lowering N_2O emissions. An increase in the NH_3 to NO_X ratio could also further reduce NO_X emissions; however this would also adversely affect NH_3 slip and N_2O formation. The inability of NH_3 slip catalysts to handle the increased NH_3 load and the EPA NH_3 slip limit of 10 ppm would guard against this NH_3 to NO_X ratio increase, and thus subsequent N_2O increase.

In summary, EPA believes that engine manufacturers would be able to respond with highly efficient NO_X reducing systems that can meet the proposed lower N_2O cap of 0.05 g/hp-hr with no additional cost or lead time. When optimizing SCR systems for better NO_X reduction efficiency, that optimization includes lowering the emissions of undesirable side reactions, including those that form N_2O.

(4) EPA Engine Standards for Methane

EPA is proposing to apply the Phase 1 methane engine standards to the Phase 2 program. EPA adopted the cap standards for CH_4 (along with N_2O standards) as engine-based standards because the agency believes that emissions of this GHG are technologically related solely to the engine, fuel, and emissions aftertreatment systems, and the agency is not aware of any influence of vehicle-based technologies on these emissions. Note that NHTSA did not adopt standards for CH_4 (or N_2O) because these emissions do not impact fuel consumption in a significant way, and is not proposing CH_4 standards for Phase 2 either.

EPA continues to believe that manufacturers of most engine technologies will be able to comply with the Phase 1 CH_4 standard with no technological improvements. We note that we are not aware of any new technologies that would allow us to adopt more stringent standards at this time. We request comment on this.

(5) Compliance Provisions and Flexibilities for Engine Standards

The agencies are proposing to continue most of the Phase 1 compliance provisions and flexibilities for the Phase 2 engine standards.

(a) Averaging, Banking, and Trading

The agencies' general approach to averaging is discussed in Section I. We are not proposing to offer any special credits to engine manufacturers. Except for early credits and advanced technology credits, the agencies propose to retain all Phase 1 credit flexibilities and limitations to continue for use in the Phase 2 program.

As discussed below, EPA is proposing to change the useful life for LHD engines for GHG emissions from the current 10 years/110,000 miles to 15 years/150,000 miles to be consistent with the useful life of criteria pollutants recently updated in EPA's Tier 3 rule. In order to ensure that banked credits would maintain their value in the transition from Phase 1 to Phase 2, NHTSA and EPA propose an adjustment factor of 1.36 (*i.e.,* 150,000 mile ÷ 110,000 miles) for credits that are carried forward from Phase 1 to the MY 2021 and later Phase 2 standards. Without this adjustment factor the proposed change in useful life would effectively result in a discount of banked credits that are carried forward from Phase 1 to Phase 2, which is not the intent of the change in the useful life. See Sections V and VI for additional discussion of similar adjustments of vehicle-based credits.

(b) Request for Comment on Changing Global Warming Potential Values in the Credit Program for CH_4 and N_2O

The Phase 1 rule included a compliance alternative allowing heavy-duty manufacturers and conversion companies to comply with the respective methane or nitrous oxide standards by means of over-complying with CO_2 standards (40 CFR 1036.705(d)). The heavy-duty rules allow averaging only between vehicles or engines of the same designated type (referred to as an ''averaging set'' in the rules). Specifically, the phase 1 heavy-duty rulemaking added a CO_2 credits program which allowed heavy-duty manufacturers to average and bank pollutant emissions to comply with the methane and nitrous oxide requirements after adjusting the CO_2 emission credits based on the relative GHG equivalents. To establish the GHG equivalents used by the CO_2 credits program, the Phase 1 rule incorporated the IPCC Fourth Assessment Report global warming potential (GWP) values of 25 for CH_4 and 298 for N_2O, which are assessed over a 100 year lifetime.

Since the Phase 1 rule was finalized, a new IPCC report has been released (the Fifth Assessment Report), with new GWP estimates. This is prompting us to look again at the relative CO_2 equivalency of methane and nitrous oxide and to seek comment on whether the methane and nitrous oxide GWPs used to establish the GHG equivalency value for the CO_2 Credit program should be updated to those established by IPCC in its Fifth Assessment Report. The Fifth Assessment Report provides four 100 year GWPs for methane ranging from 28 to 36 and two 100 year GWPs for nitrous oxide, either 265 or 298. Therefore, we not only request comment on whether to update the GWP for methane and nitrous oxide to that of the Fifth Assessment Report, but also on which value to use from this report.

(c) In-Use Compliance and Useful Life

Consistent with Section 202(a)(1) and 202 (d) of the CAA, for Phase 1, EPA established in-use standards for heavy-duty engines. Based on our assessment of testing variability and other relevant factors, we established in-use standards by adding a 3 percent adjustment factor to the full useful life emissions and fuel consumption results measured in the EPA certification process to address measurement variability inherent in comparing results among different laboratories and different engines. See 40 CFR part 1036. The agencies are not proposing to change this for Phase 2, but request comment on whether this allowance is still necessary.

We note that in Phase 1, we applied these standards to only certain engine configurations in each engine family (often called the parent rating). We welcome comment on whether the agencies should set Phase 2 CO_2 and fuel consumption standards for the other ratings (often called the child ratings) within an engine family. We are not proposing specific engine standards for child ratings in Phase 2 because we are proposing to include the actual engine's fuel map in the vehicle certification. We believe this approach appropriately addresses our concern that manufacturers control CO_2 emissions and fuel consumption from all in-use engine configurations within an engine family.

In Phase 1, EPA set the useful life for engines and vehicles with respect to GHG emissions equal to the respective useful life periods for criteria pollutants. In April 2014, as part of the Tier 3 light-duty vehicle final rule, EPA extended the regulatory useful life period for criteria pollutants to 150,000 miles or 15 years, whichever comes first, for Class 2b and 3 pickup trucks and vans and some light-duty trucks (79 FR 23414, April 28, 2014). As described in Section V, EPA is proposing that the Phase 2 GHG standards for vocational vehicles at or below 19,500 lbs GVWR apply over the same useful life of 150,000 miles or 15 years. To be consistent with that proposed change, we are also proposing that the Phase 2 GHG standards for engines used in vocational vehicles at or below 19,500 lbs GVWR apply over the same useful life of 150,000 miles or 15 years. NHTSA proposes to use the same useful life values as EPA for all vocational vehicles.

We are proposing to continue regulatory allowance in 40 CFR 1036.150(g) that allows engine manufacturers to use assigned deterioration factors (DFs) for most engines without performing their own durability emission tests or engineering analysis. However, the engines would still be required to meet the standards in actual use without regard to whether the manufacturer used the assigned DFs. This allowance is being continued as an interim provision and may be discontinued for later phases of standards as more information becomes known. Manufacturers are allowed to use an assigned additive DF of 0.0 g/bhp-hr for CO_2 emissions from any conventional engine (*i.e.,* an engine not including advance or off-cycle technologies). Upon request, we could allow the assigned DF for CO_2 emissions from engines including advance or off-cycle technologies, but only if we determine that it would be consistent with good engineering judgment. We believe that we have enough information about in-use CO_2 emissions from conventional engines to conclude that they will not increase as the engines age. However, we lack such information about the more advanced technologies.

We are also requesting comment on how to apply DFs to low level measurements where test-to-test variability may be larger than the actual deterioration rates being measured, such as might occur with N_2O. Should we allow statistical analysis to be used to identifying trends rather than basing the DF on the highest measured value? How would we allow this where emission deterioration is not linear, such as saw-tooth deterioration related to maintenance or other offsetting emission effects causing emissions to peak before the end of the useful life? Finally, EPA requests comment on whether a similar allowance would be appropriate for criteria pollutants as well.

(d) Alternate CO_2 Standards

In the Phase 1 rulemaking, the agencies proposed provisions to allow certification to alternate CO_2 engine standards in model years 2014 through 2016. This flexibility was intended to address the special case of needed lead time to implement new standards for a previously unregulated pollutant. Since that special case does not apply for Phase 2, we are not proposing a similar flexibility in this rulemaking. We also request comment on whether this allowance should be eliminated for Phase 1 engines.

(e) Proposed Approach to Standards and Compliance Provisions for Natural Gas Engines

EPA is also proposing certain clarifying changes to its rules regarding classification of natural gas engines. This proposal relates to standards for all emissions, both greenhouse gases and criteria pollutants. These clarifying changes are intended to reflect the status quo, and therefore should not have any associated costs.

EPA emission standards have always applied differently for gasoline-fueled and diesel-fueled engines. The regulations in 40 CFR part 86 implement these distinctions by dividing engines into Otto-cycle and Diesel-cycle technologies. This approach led EPA to categorize natural gas engines according to their design history. A diesel engine converted to run on natural gas was classified as a diesel-cycle engine; a gasoline engine converted to run on natural gas was classified as an Otto-cycle engine.

The Phase 1 rule described our plan to transition to a different approach, consistent with our nonroad programs, in which we divide engines into compression-ignition and spark-ignition technologies based only on the operating characteristics of the engines.[109] However, the Phase 1 rule included a provision allowing us to continue with the historic approach on an interim basis.

Under the existing EPA regulatory definitions of ''compression-ignition'' and ''spark-ignition'', a natural gas engine would generally be considered compression-ignition if it operates with lean air-fuel mixtures and uses a pilot injection of diesel fuel to initiate combustion, and would generally be considered spark-ignition if it operates with stoichiometric air-fuel mixtures and uses a spark plug to initiate combustion.

EPA's basic premise here is that natural gas engines performing similar in-use functions should be subject to similar regulatory requirements. The compression-ignition emission standards and testing requirements reflect the operating characteristics for the full range of heavy-duty vehicles, including substantial operation in long-haul service characteristic of tractors. The spark-ignition emission standards and testing requirements do not include some of those provisions related to use in long-haul service or other applications where diesel engines predominate, such as steady-state testing, Not-to-Exceed standards, and extended useful life. We believe it would be inappropriate to apply the spark-ignition standards and requirements to natural gas engines that would be used in applications mostly served by diesel engines today. We are therefore proposing to replace the interim provision described above with a differentiated approach to certification of natural gas engines across all of the EPA standards—for both GHGs and criteria pollutants. Under the proposed clarifying amendment, we would require manufacturers to divide all their natural gas engines into primary intended service classes, as we already require for compression-ignition engines, whether or not the engine has features that otherwise could (in theory) result in classification as SI under the current rules. Any natural gas engine qualifying as a medium heavy-duty engine (19,500 to 33,000 lbs GVWR) or a heavy heavy-duty engine (over 33,000 lbs GVWR) would be subject to all the emission standards and other requirements that apply to compression-ignition engines.

Table II–17 describes the provisions that would apply differently for compression-ignition and spark-ignition engines:

TABLE II–17—REGULATORY PROVISIONS THAT ARE DIFFERENT FOR COMPRESSION-IGNITION AND SPARK-IGNITION ENGINES

Provision	Compression-ignition	Spark-ignition
Transient duty cycle	40 CFR part 86, Appendix I, paragraph (f)(2) cycle; divide by 1.12 to de-normalize.	40 CFR part 86, Appendix I, paragraph (f)(1) cycle.
Ramped-modal test (SET)	yes	no.
NTE standards	yes	no.
Smoke standard	yes	no.
Manufacturer-run in-use testing	yes	no.
ABT—pollutants	NO_X, PM	NO_X, NMHC.
ABT— transient conversion factor	6.5	6.3.
ABT—averaging set	Separate averaging sets for light, medium, and heavy HDDE	One averaging set for all SI engines.
Useful life	110,000 miles for light HDDE 185,000 miles for medium HDDE. 435,000 miles for heavy HDDE.	110,000 miles
Warranty	50,000 miles for light HDDE 100,000 miles for medium HDDE. 100,000 miles for heavy HDDE.	50,000 miles.
Detailed AECD description	yes	no.
Test engine selection	highest injected fuel volume	most likely to exceed emission standards.

The onboard diagnostic requirements already differentiate requirements by fuel type, so there is no need for those provisions to change based on the considerations of this section.

We are not aware of any currently certified engines that would change from compression-ignition to spark-ignition under the proposed clarified approach. Nonetheless, because these proposed standards implicate rules for criteria pollutants (as well as GHGs), the provisions of CAA section 202(a)(3)(C) apply (for the criteria pollutants), notably the requirement of four years lead time. We are therefore proposing to continue to apply the existing interim provision through model year 2020.[110]

[109] See 40 CFR 1036.108.

[110] Section 202(a)(2), applicable to emissions of greenhouse gases, does not mandate a specific period of lead time, but EPA sees no reason for a different compliance date here for GHGs and

Continued

Starting in model year 2021, all the provisions would apply as described above. Manufacturers would not be permitted to certify any engine families using carryover emission data if a particular engine model switched from compression-ignition to spark-ignition, or vice versa. However, as noted above, in practice these vehicles are already being certified as CI engines, so we view these changes as clarifications ratifying the current status quo.

We are also proposing that these provisions would apply equally to engines fueled by any fuel other than gasoline or ethanol, should such engines be produced in the future. Given the current and historic market for vehicles above 19,500 lbs GVWR, EPA believes any alternative-fueled vehicles in this weight range would be competing primarily with diesel vehicles and should be subject to the same requirements as them. We request comment on all aspects of classifying natural-gas and other engines for purposes of applying emission standards. See Sections XI and XII for additional discussion of natural gas fueled engines.

(f) Crankcase Emissions From Natural Gas Engines

EPA is proposing one fuel-specific provision for natural gas engines, likewise applicable to all pollutant emissions, both GHGs and criteria pollutant emissions. Note that we are also proposing other vehicle-level emissions controls for the natural gas storage tanks and refueling connections. These are presented in Section XIII.

EPA is proposing to require that all natural gas-fueled engines have closed crankcases, rather than continuing the provision that allows venting to the atmosphere all crankcase emissions from all compression-ignition engines. This has been allowed as long as these vented crankcase emissions are measured and accounted for as part of an engine's tailpipe emissions. This allowance has historically been in place to address the technical limitations related to recirculating diesel-fueled engines' crankcase emissions, which have high PM emissions, back into the engine's air intake. High PM emissions vented into the intake of an engine can foul turbocharger compressors and aftercooler heat exchangers. In contrast, historically EPA has mandated closed crankcase technology on all gasoline fueled engines and all natural gas spark-ignition engines.[111] The inherently low PM emissions from these engines posed no technical barrier to a closed crankcase mandate. Because natural gas-fueled compression ignition engines also have inherently low PM emissions, there is no technological limitation that would prevent manufacturers from closing the crankcase and recirculating all crankcase gases into a natural gas-fueled compression ignition engine's air intake. We are requesting comment on the costs and effectiveness of technologies that we have identified to comply with these provisions. In addition, EPA is proposing that this revised standard not take effect until the 2021 model year, consistent with the requirement of section 202(a)(3)(C) to provide four years lead time.

III. Class 7 and 8 Combination Tractors

Class 7 and 8 combination tractors-trailers contribute the largest portion of the total GHG emissions and fuel consumption of the heavy-duty sector, approximately two-thirds, due to their large payloads, their high annual miles traveled, and their major role in national freight transport.[112] These vehicles consist of a cab and engine (tractor or combination tractor) and a trailer.[113] In general, reducing GHG emissions and fuel consumption for these vehicles would involve improvements to all aspects of the vehicle.

As we found during the development in Phase 1 and as continues to be true in the industry today, the heavy-duty combination tractor-trailer industry consists of separate tractor manufacturers and trailer manufacturers. We are not aware of any manufacturer that typically assembles both the finished truck and the trailer and introduces the combination into commerce for sale to a buyer. There are also large differences in the kinds of manufacturers involved with producing tractors and trailers. For HD highway tractors and their engines, a relatively limited number of manufacturers produce the vast majority of these products. The trailer manufacturing industry is quite different, and includes a large number of companies, many of which are relatively small in size and production volume. Setting standards for the products involved—tractors and trailers—requires recognition of the large differences between these manufacturing industries, which can then warrant consideration of different regulatory approaches. Thus, although tractor-trailers operate essentially as a unit from both a commercial standpoint and for purposes of fuel efficiency and CO_2 emissions, the agencies have developed separate proposed standards for each.

Based on these industry characteristics, EPA and NHTSA believe that the most appropriate regulatory approach for combination tractors and trailers is to establish standards for tractors separately from trailers. As discussed below in Section IV, the agencies are also proposing standards for certain types of trailers.

A. Summary of the Phase 1 Tractor Program

The design of each tractor's cab and drivetrain determines the amount of power that the engine must produce in moving the truck and its payload down the road. As illustrated in Figure III–1, the loads that require additional power from the engine include air resistance (aerodynamics), tire rolling resistance, and parasitic losses (including accessory loads and friction in the drivetrain). The importance of the engine design is that it determines the basic GHG emissions and fuel consumption performance for the variety of demands placed on the vehicle, regardless of the characteristics of the cab in which it is installed.

criteria pollutants. This is also true with respect to the closed crankcase emission discussed in the following subsection.

[111] See 40 CFR 86.008–10(c).

[112] The on-highway Class 7 and 8 combination tractor-trailers constitute the vast majority of this regulatory category. A small fraction of combination tractors are used in off-road applications and are regulated differently, as described in Section III.C.

[113] ''Tractor'' is defined in 49 CFR 571.3 to mean ''a truck designed primarily for drawing other motor vehicles and not so constructed as to carry a load other than a part of the weight of the vehicle and the load so drawn.''

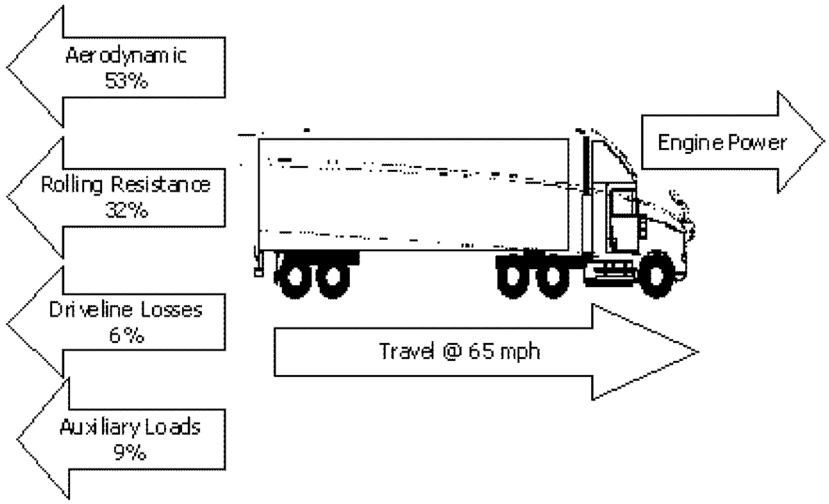

Figure III-1 Combination Tractor and Trailer Loads[114]

Accordingly, for Class 7 and 8 combination tractors, the agencies adopted two sets of Phase 1 tractor standards for fuel consumption and CO_2 emissions. The CO_2 emission and fuel consumption reductions related to engine technologies are recognized in the engine standards. For vehicle-related emissions and fuel consumption, tractor manufacturers are required to meet vehicle-based standards. Compliance with the vehicle standard must be determined using the GEM vehicle simulation tool.

The Phase 1 tractor standards were based on several key attributes related to GHG emissions and fuel consumption that reasonably represent the many differences in utility and performance among these vehicles. Attribute-based standards in general recognize the variety of functions performed by vehicles and engines, which in turn can affect the kind of technology that is available to control emissions and reduce fuel consumption, or its effectiveness. Attributes that characterize differences in the design of vehicles, as well as differences in how the vehicles will be employed in-use, can be key factors in evaluating technological improvements for reducing CO_2 emissions and fuel consumption. Developing an appropriate attribute-based standard can also avoid interfering with the ability of the market to offer a variety of products to meet the customer's demand. The Phase 1 tractor standards differ depending on GVWR (*i.e.,* whether the truck is Class 7 or Class 8), the height of the roof of the cab, and whether it is a ''day cab'' or a ''sleeper cab.'' These later two attributes are important because the height of the roof, designed to correspond to the height of the trailer, significantly affects air resistance, and a sleeper cab generally corresponds to the opportunity for extended duration idle emission and fuel consumption improvements. Based on these attributes, the agencies created nine subcategories within the Class 7 and 8 combination tractor category. The Phase 1 rules set standards for each of them. Phase 1 standards began with the 2014 model year and were followed with more stringent standards following in model year 2017.[115] The standards represent an overall fuel consumption and CO_2 emissions reduction up to 23 percent from the tractors and the engines installed in them when compared to a baseline 2010 model year tractor and engine without idle shutdown technology. Although the EPA and NHTSA standards are expressed differently (grams of CO_2 per ton-mile and gallons per 1,000 ton-mile respectively), the standards are equivalent.

In Phase 1, the agencies allowed manufacturers to certify certain types of combination tractors as vocational vehicles. These are tractors that do not typically operate at highway speeds, or would otherwise not benefit from efficiency improvements designed for line-haul tractors (although standards would still apply to the engines installed in these vehicles). The agencies created a subcategory of ''vocational tractors,'' or referred to as ''special purpose tractors'' in 40 CFR part 1037, because real world operation of these tractors is better represented by our Phase 1 vocational vehicle duty cycle than the tractor duty cycles. Vocational tractors are subject to the standards for vocational vehicles rather than the combination tractor standards. In addition, specific vocational tractors and heavy-duty vocational vehicles primarily designed to perform work off-road or having tires installed with a maximum speed rating at or below 55 mph are exempted from the Phase 1 standards.

In Phase 1, the agencies also established separate performance standards for the engines manufactured for use in these tractors. EPA's engine-based CO_2 standards and NHTSA's engine-based fuel consumption standards are being implemented using EPA's existing test procedures and regulatory structure for criteria pollutant emissions from medium- and heavy-duty engines. These engine standards vary depending on engine size linked to intended vehicle service class (which are the same service classes used for many years for EPA's criteria pollutant standards).

Manufacturers demonstrate compliance with the Phase 1 tractor standards using the GEM simulation tool. As explained in Section II above, GEM is a customized vehicle simulation model which is the preferred approach to demonstrating compliance testing for combination tractors rather than chassis dynamometer testing used in light-duty vehicle compliance. As discussed in the development of HD Phase 1 and recommended by the NAS 2010 study,

[114] Adapted from Figure 4.1. Class 8 Truck Energy Audit, Technology Roadmap for the 21st Century Truck Program: A Government-Industry Research Partnership, 21CT–001, December 2000.

[115] Manufacturers may voluntarily opt-in to the NHTSA fuel consumption standards in model years 2014 or 2015. Once a manufacturer opts into the NHTSA program it must stay in the program for all optional MYs.

a simulation tool is the preferred approach for HD tractor compliance because of the extremely large number of vehicle configurations.[116] The GEM compliance tool was developed by EPA and is an accurate and cost-effective alternative to measuring emissions and fuel consumption while operating the vehicle on a chassis dynamometer. Instead of using a chassis dynamometer as an indirect way to evaluate real world operation and performance, various characteristics of the vehicle are measured and these measurements are used as inputs to the model. For HD Phase 1, these characteristics relate to key technologies appropriate for this category of truck including aerodynamic features, weight reductions, tire rolling resistance, the presence of idle-reducing technology, and vehicle speed limiters. The model also assumes the use of a representative typical engine in compliance with the separate, applicable Phase 1 engine standard. Using these inputs, the model is used to quantify the overall performance of the vehicle in terms of CO_2 emissions and fuel consumption. CO_2 emission reduction and fuel consumption technologies not measured by the model must be evaluated separately, and the HD Phase 1 rules establish mechanisms allowing credit for such ''off-cycle'' technologies.

In addition to the final Phase 1 tractor-based standards for CO_2, EPA adopted a separate standard to reduce leakage of HFC refrigerant from cabin air conditioning (A/C) systems from combination tractors, to apply to the tractor manufacturer. This HFC leakage standard is independent of the CO_2 tractor standard. Manufacturers can choose technologies from a menu of leak-reducing technologies sufficient to comply with the standard, as opposed to using a test to measure performance.

The Phase 1 program also provided several flexibilities to advance the goals of the overall program while providing alternative pathways to achieve compliance. The primary flexibility is the averaging, banking, and trading program which allows emissions and fuel consumption credits to be averaged within an averaging set, banked for up to five years, or traded among manufacturers. Manufacturers with credit deficits were allowed to carry-forward credit deficits for up to three model years, similar to the LD GHG and CAFE carry-back credits. Phase 1 also included several interim provisions, such as incentives for advanced technologies and provisions to obtain credits for innovative technologies (called off-cycle in the Phase 2 program) not accounted for by the HD Phase 1 version of GEM or for certifying early.

B. Overview of the Proposed Phase 2 Tractor Program

The proposed HD Phase 2 program is similar in many respects to the Phase 1 approach. The agencies are proposing to maintain the Phase 1 attribute-based regulatory structure in terms of dividing the tractor category into the same nine subcategories based on the tractor's GVWR, cab configuration, and roof height. This structure is working well in the implementation of Phase 1. The one area where the agencies are proposing to change the regulatory structure is related to heavy-haul tractors. As noted above, the Phase 1 regulations include a set of provisions that allow vocational tractors to be treated as vocational vehicles. However, because the agencies propose to include the powertrain as part of the technology basis for the tractor and vocational vehicle standards in Phase 2, we are proposing to classify a certain set of these vocational tractors as heavy-haul tractors and subject them to a separate tractor standard that reflects their unique powertrain requirements and limitations in application of technologies to reduce fuel consumption and CO_2 emissions.[117]

The agencies propose to also retain much of the certification and compliance structure developed in Phase 1 but to simplify end of the year reporting. The agencies propose that the Phase 2 tractor CO_2 emissions and fuel consumption standards, as in Phase 1, be aligned.[118] The agencies also propose to continue to have separate engine and vehicle standards to drive technology improvements in both areas. The reasoning behind the proposal to maintain separate standards is discussed above in Section II.B.2. As in Phase 1, the agencies propose to certify tractors using the GEM simulation tool and to require manufacturers to evaluate the performance of subsystems through testing (the results of this testing to be used as inputs to the GEM simulation tool). Other aspects of the proposed HD Phase 2 certification and compliance program also mirror the Phase 1 program, such as maintaining a single reporting structure to satisfy both agencies, requiring limited data at the beginning of the model year for certification, and determining compliance based on end of year reports. In the Phase 1 program, manufacturers participating in the ABT program provided 90 day and 270 day reports after the end of the model year. The agencies required two reports for the initial program to help manufacturers become familiar with the reporting process. For the Phase 2 program, the agencies propose that manufacturers would only be required to submit one end of the year report, which would simplify reporting.

Even though many aspects of the proposed HD Phase 2 program are similar to Phase 1, there are some key differences. While Phase 1 focused on reducing CO_2 emissions and fuel consumption in tractors through the application of existing (''off-the-shelf'') technologies, the proposed HD Phase 2 standards seek additional reductions through increased use of existing technologies and the development and deployment of more advanced technologies. To evaluate the effectiveness of a more comprehensive set of technologies, the agencies propose several additional inputs to GEM. The proposed set of inputs includes the Phase 1 inputs plus parameters to assess the performance of the engine, transmission, and driveline. Specific inputs for, among others, predictive cruise control, automatic tire inflation systems, and 6x2 axles would now be required. Manufacturers would conduct component testing to obtain the values for these technologies (should they choose to use them), which testing values would then be input into the GEM simulation tool. See Section III.D.2 below. To effectively assess performance of the technologies, the agencies also propose to change some aspects of the drive cycle used in certification through the addition of road grade. To reflect the existing trailer market, the agencies are proposing to refine the aerodynamic test procedure for high roof cabs by adding some aerodynamic improving devices to the reference trailer (used for determining the relative aerodynamic performance of the tractor). The agencies also propose to change the aerodynamic certification test procedure to capture aerodynamic improvement of trailers and the impact of wind on tractor aerodynamic performance. The agencies are also proposing to change some of the interim provisions developed in Phase 1 to reflect the maturity of the program and

[116] National Academy of Science. ''Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles.'' 2010. Recommendation 8–4 stated ''Simulation modeling should be used with component test data and additional tested inputs from powertrain tests, which could lower the cost and administrative burden yet achieve the needed accuracy of results.''

[117] See 76 FR 57138 for Phase 1 discussion. See 40 CFR 1037.801 for proposed Phase 2 heavy-haul tractor regulatory definition.

[118] Fuel consumption is calculated from CO_2 using the conversion factor of 10,180 grams of CO_2 per gallon for diesel fuel.

reduced need and justification for some of the Phase 1 flexibilities. Further discussions on all of these matters are covered in the following sections.

C. Proposed Phase 2 Tractor Standards

EPA is proposing CO_2 standards and NHTSA is proposing fuel consumption standards for new Class 7 and 8 combination tractors. In addition, EPA is proposing to maintain the HFC standards for the air conditioning systems that were adopted in Phase 1. EPA is also seeking comment on new standards to further control emissions of particulate matter (PM) from auxiliary power units (APU) installed in tractors that would prevent an unintended consequence of increasing PM emissions from tractors during long duration idling.

This section describes in detail the proposed standards. In addition to describing the proposed alternative (''Alternative 3''), in Section III.D.2.f we also detail another alternative (''Alternative 4''). Alternative 4 provides less lead time than the proposed set of standards but may provide more net benefits in the form of greater emission and fuel consumption reductions (with somewhat higher costs) in the early years of the program. The agencies believe Alternative 4 has the potential to be maximum feasible and appropriate as discussed later in this section.

The agencies welcome comment on all aspects of the proposed standards and the alternative standards described in Section III.D.2.f. Commenters are encouraged to address all aspects of feasibility analysis, including costs, the likelihood of developing the technology to achieve sufficient relaibility within the proposed and alternative lead-times, and the extent to which the market could utilize the technology. It would be helpful if comments addressed these issues separately for each type of technology.

(1) Proposed Fuel Consumption and CO_2 Standards

The proposed fuel consumption and CO_2 standards for the tractor cab are shown below in Table III–1. These proposed standards would achieve reductions of up to 24 percent compared to the 2017 model year baseline level when fully phased in beginning in the 2027 MY.[119] The proposed standards for Class 7 are described as ''Day Cabs'' because we are not aware of any Class 7 sleeper cabs in the market today; however, the agencies propose to require any Class 7 tractor, regardless of cab configuration, meet the standards described as ''Class 7 Day Cab.'' We welcome comment on this proposed approach.

The agencies' analyses, as discussed briefly below and in more detail later in this preamble and in the draft RIA Chapter 2, indicate that these proposed standards, if finalized, would be maximum feasible (within the meaning of 49 U.S.C. Section 32902 (k)) and would be appropriate under each agency's respective statutory authorities. The agencies solicit comment on all aspects of these analyses.

TABLE III–1—PROPOSED PHASE 2 HEAVY-DUTY COMBINATION TRACTOR EPA EMISSIONS STANDARDS (g CO_2/ton-mile) AND NHTSA FUEL CONSUMPTION STANDARDS (gal/1,000 ton-mile)

	Day cab		Sleeper cab
	Class 7	Class 8	Class 8
2021 Model Year CO_2 Grams per Ton-Mile			
Low Roof	97	78	70
Mid Roof	107	84	78
High Roof	109	86	77
2021 Model Year Gallons of Fuel per 1,000 Ton-Mile			
Low Roof	9.5285	7.6621	6.8762
Mid Roof	10.5108	8.2515	7.6621
High Roof	10.7073	8.4479	7.5639
2024 Model Year CO_2 Grams per Ton-Mile			
Low Roof	90	72	64
Mid Roof	100	78	71
High Roof	101	79	70
2024 Model Year and Later Gallons of Fuel per 1,000 Ton-Mile			
Low Roof	8.8409	7.0727	6.2868
Mid Roof	9.8232	7.6621	6.9745
High Roof	9.9214	7.7603	6.8762
2027 Model Year CO_2 Grams per Ton-Mile			
Low Roof	87	70	62
Mid Roof	96	76	69
High Roof	96	76	67
2027 Model Year and Later Gallons of Fuel per 1,000 Ton-Mile			
Low Roof	8.5462	6.8762	6.0904
Mid Roof	9.4303	7.4656	6.7780

[119] Since the HD Phase 1 tractor standards fully phase-in by the MY 2017, this is the logical baseline year.

TABLE III–1—PROPOSED PHASE 2 HEAVY-DUTY COMBINATION TRACTOR EPA EMISSIONS STANDARDS (g CO_2/ton-mile) AND NHTSA FUEL CONSUMPTION STANDARDS (gal/1,000 ton-mile)—Continued

	Day cab		Sleeper cab
	Class 7	Class 8	Class 8
High Roof	9.4303	7.4656	6.5815

It should be noted that the proposed HD Phase 2 CO_2 and fuel consumptions standards are not directly comparable to the Phase 1 standards. This is because the agencies are proposing several test procedure changes to more accurately reflect real world operation of tractors. These changes will result in the following differences. First, the same vehicle evaluated using the proposed HD Phase 2 version of GEM will obtain higher (*i.e.* less favorable) CO_2 and fuel consumption values because the Phase 2 drive cycles include road grade. Road grade, which (of course) exists in the real-world, requires the engine to operate at higher horsepower levels to maintain speed while climbing a hill. Even though the engine saves fuel on a downhill section, the overall impact increases CO_2 emissions and fuel consumption. The second of the key differences between the CO_2 and fuel consumption values in Phase 1 and Phase 2 is due to proposed changes in the evaluation of aerodynamics. In the real world, vehicles are exposed to wind which increases the drag of the vehicle and in turn increases the power required to move the vehicle down the road. To more appropriately reflect the in-use aerodynamic performance of tractor-trailers, the agencies are proposing to input into Phase 2 GEM the wind averaged coefficient of drag instead of the no-wind (zero yaw) value used in Phase 1. The final key difference between Phase 1 and the proposed Phase 2 program includes a more realistic and improved simulation of the transmission in GEM, which could increase CO_2 and fuel consumption relative to Phase 1.

The agencies are proposing Phase 2 CO_2 emissions and fuel consumption standards for the combination tractors that reflect reductions that can be achieved through improvements in the tractor's powertrain, aerodynamics, tires, and other vehicle systems. The agencies have analyzed the feasibility of achieving the proposed CO_2 and fuel consumption standards, and have identified means of achieving the proposed standards that are technically feasible in the lead time afforded, economically practicable and cost-effective. EPA and NHTSA present the estimated costs and benefits of the proposed standards in Section III.D.2. In developing the proposed standards for Class 7 and 8 tractors, the agencies have evaluated the following:

- the current levels of emissions and fuel consumption
- the kinds of technologies that could be utilized by tractor and engine manufacturers to reduce emissions and fuel consumption from tractors and associated engines
- the necessary lead time
- the associated costs for the industry
- fuel savings for the consumer
- the magnitude of the CO_2 and fuel savings that may be achieved

The technologies on whose performance the proposed tractor standards are predicated include: Improvements in the engine, transmission, driveline, aerodynamic design, tire rolling resistance, other accessories of the tractor, and extended idle reduction technologies. These technologies, and other accessories of the tractor, are described in draft RIA Chapter 2.4. The agencies' evaluation shows that some of these technologies are available today, but have very low adoption rates on current vehicles, while others will require some lead time for development. EPA and NHTSA also present the estimated costs and benefits of the proposed Class 7 and 8 combination tractor standards in draft RIA Chapter 2.8 and 2.12, explaining as well the basis for the agencies' proposed stringency level.

As explained below in Section III.D, EPA and NHTSA have determined that there would be sufficient lead time to introduce various tractor and engine technologies into the fleet starting in the 2021 model year and fully phasing in by the 2027 model year. This is consistent with NHTSA's statutory requirement to provide four full model years of regulatory lead time for standards. As was adopted in Phase 1, the agencies are proposing for Phase 2 that manufacturers may generate and use credits from Class 7 and 8 combination tractors to show compliance with the standards. This is discussed further in Section III.F.

Based on our analysis, the 2027 model year standards for combination tractors and engines represent up to a 24 percent reduction in CO_2 emissions and fuel consumption over a 2017 model year baseline tractor, as detailed in Section III.D.2. In considering the feasibility of vehicles to comply with the proposed standards over their useful lives, EPA also considered the potential for CO_2 emissions to increase during the regulatory useful life of the product. As we discuss in Phase 1 and separately in the context of deterioration factor (DF) testing, we have concluded that CO_2 emissions are likely to stay the same or actually decrease in-use compared to new certified configurations. In general, engine and vehicle friction decreases as products wear, leading to reduced parasitic losses and consequent lower CO_2 emissions. Similarly, tire rolling resistance falls as tires wear due to the reduction in tread height. In the case of aerodynamic components, we project no change in performance through the regulatory life of the vehicle since there is essentially no change in their physical form as vehicles age. Similarly, weight reduction elements such as aluminum wheels are (evidently) not projected to increase in mass through time, and hence, we can conclude will not deteriorate with regard to CO_2 performance in-use. Given all of these considerations, the agencies are confident in projecting that the tractor standards being proposed today would be technically feasible throughout the regulatory useful life of the program.

(2) Proposed Non-CO_2 GHG Standards for Tractors

EPA is also proposing standards to control non-CO_2 GHG emissions from Class 7 and 8 combination tractors.

(a) N_2O and CH_4 Emissions

The proposed heavy-duty engine standards for both N_2O and CH_4 as well as details of the proposed standards are included in the discussion in Section II.D.3 and II.D.4. No additional controls for N_2O or CH_4 emissions beyond those in the proposed HD Phase 2 engine standards are being considered for the tractor category.

(b) HFC Emissions

Manufacturers can reduce hydrofluorocarbon (HFC) emissions from air conditioning (A/C) leakage emissions in two ways. First, they can utilize leak-tight A/C system components. Second, manufacturers can largely eliminate the global warming impact of leakage emissions by adopting systems that use an alternative, low-Global Warming Potential (GWP) refrigerant, to replace the commonly used R–134a refrigerant. EPA proposes to address HFC emissions by maintaining the A/C leakage standards adopted in HD Phase 1 (see 40 CFR 1037.115). EPA believes the Phase 1 use of leak-tight components is at an appropriate level of stringency while maintaining the flexibility to produce the wide variety of A/C system configurations required in the tractor category. In addition, there currently are not any low GWP refrigerants approved for the heavy-duty vehicle sector. Without an alternative refrigerant approved for this sector, it is challenging to demonstrate feasibility to reduce the amount of leakage allowed under the HFC leakage standard. Please see Section I.F(1)(b) for a discussion related to alternative refrigerants.

(3) PM Emissions From APUs

Auxiliary power units (APUs) can be used in lieu of operating the main engine during extended idle operations to provide climate control and power to the driver. APUs can reduce fuel consumption, NO_X, HC, CH_4, and CO_2 emissions when compared to main engine idling.[120] However, a potential unintended consequence of reducing CO_2 emissions from combination tractors through the use of APUs during extended idle operation is an increase in PM emissions. Therefore, EPA is seeking comment on the need and appropriateness to further reduce PM emissions from APUs.

EPA conducted an analysis evaluating the potential impact on PM emissions due to an increase in APU adoption rates using MOVES. In this analysis, EPA assumed that these APUs emit criteria pollutants at the level of the EPA standard for this type of non-road diesel engines. Under this assumption, an APU would emit 1.8 grams PM per hour, assuming an extended idle load demand of 4.5 kW (6 hp).[121] However, a 2010 model year or newer tractor that uses its main engine to idle emits approximately 0.35 grams PM per hour.[122] The results from these MOVES runs are shown below in Table III–2. These results show that an increase in use of APUs could lead to an overall increase in PM emissions if left uncontrolled. Column three labeled ''Proposed Program $PM_{2.5}$ Emission Impact without Further PM Control (tons)'' shows the incremental increase in $PM_{2.5}$ without further regulation of APU $PM_{2.5}$ emissions.

TABLE III–2—PROJECTED IMPACT OF INCREASED ADOPTION OF APUS IN PHASE 2

CY	Baseline HD vehicle $PM_{2.5}$ emissions (tons)	Proposed program $PM_{2.5}$[a] emission impact without further PM control (tons)
2035	21,452	1,631
2050	24,675	2,257

Note:
[a] Positive numbers mean emissions would increase from baseline to control case. $PM_{2.5}$ from tire wear and brake wear are included.

Since January 1, 2008, California ARB has prohibited the idling of sleeper cab tractors during periods of sleep and rest.[123] The regulations apply additional requirements to diesel-fueled APUs on tractors equipped with 2007 model year or newer engines. Truck owners in California must either: (1) Fit the APU with an ARB verified Level 3 particulate control device that achieves 85 percent reduction in particulate matter; or (2) have the APU exhaust plumbed into the vehicle's exhaust system upstream of the particulate matter aftertreatment device.[124] Currently ARB includes four control devices that have been verified to meet the Level 3 p.m. requirements. These devices include HUSS Umwelttechnik GmbH's FS–MK Series Diesel Particulate filters, Impco Ecotrans Technologies' ClearSky Diesel Particulate Filter, Thermo King's Electric Regenerative Diesel Particulate Filter, and Proventia's Electronically Heated Diesel Particulate Filter. In addition, ARB has approved a Cummins integrated diesel-fueled APU and several fuel-fired heaters produced by Espar and Webasto.

EPA conducted an evaluation of the impact of potentially requiring further PM control from APUs nationwide. As shown in Table III–2, EPA projects that the HD Phase 2 program as proposed (without additional PM controls) would increase $PM_{2.5}$ emissions by 1,631 tons in 2035 and 2,257 tons in 2050. The annual impact of a program to further control PM could lead to a reduction of $PM_{2.5}$ emissions nationwide by 3,084 tons in 2035 and by 4,344 tons in 2050, as shown in Table III–3 the column labeled ''Net Impact on National $PM_{2.5}$ Emission with Further PM Control of APUs (tons).''

[120] U.S. EPA. Development of Emission Rates for Heavy-Duty Vehicles in the Motor Vehicle Emissions Simulator MOVES 2010. EPA–420–B–12–049. August 2012.

[121] Tier 4, less-than-8 kW nonroad compression-ignition engine exhaust emissions standards assumed for APUs: *http://www.epa.gov/otaq/standards/nonroad/nonroadci.htm.*

[122] U.S. EPA. MOVES2014 Reports. Last accessed on May 1, 2015 at *http://www.epa.gov/otaq/models/moves/moves-reports.htm.*

[123] California Air Resources Board. Idle Reduction Technologies for Sleeper Berth Trucks. Last viewed on September 19, 2014 at *http://www.arb.ca.gov/msprog/cabcomfort/cabcomfort.htm.*

[124] California Air Resources Board. § 2485(c)(3)(A)(1).

TABLE III–3—PROJECTED IMPACT OF FURTHER CONTROL ON $PM_{2.5}$ EMISSIONS [A]

CY	Baseline national heavy-duty vehicle $PM_{2.5}$ emissions (tons)	Proposed HD phase 2 program national $PM_{2.5}$ Emissions without Further PM Control (tons)	Proposed HD Phase 2 Program National $PM_{2.5}$ emissions with further pm control (tons)	Net impact on national $PM_{2.5}$ emission with further PM control of APUs (tons)
2035	21,452	23,083	19,999	−3,084
2050	24,675	26,932	22,588	−4,344

Note:
[a] $PM_{2.5}$ from tire wear and brake wear are included.

EPA developed long-term cost projections for catalyzed diesel particulate filters (DPF) as part of the Nonroad Diesel Tier 4 rulemaking. In that rulemaking, EPA estimated the DPF costs would add $580 to the cost of 150 horsepower engines (69 FR 39126, June 29, 2004). On the other hand, ARB estimated the cost of retrofitting a diesel powered APU with a PM trap to be $2,000 in 2005.[125] The costs of a DPF for an APU that provides less than 25 horsepower would be less than the projected cost of a 150 HP engine because the filter volume is in general proportional to the engine-out emissions and exhaust flow rate. Proventia is charging customers $2,240 for electronically heated DPF.[126] EPA welcomes comments on cost estimates associated with DPF systems for APUs.

EPA requests comments on the technical feasibility of diesel particulate filters ability to reduce PM emissions by 85 percent from non-road engines used to power APUs. EPA also requests comments on whether the technology costs outlined above are accurate, and if so, if projected reductions are appropriate taking into account cost, noise, safety, and energy factors. See CAA section 213(a)(4).

(4) Proposed Exclusions From the Phase 2 Tractor Standards

As noted above, in Phase 1, the agencies adopted provisions to allow tractor manufacturers to reclassify certain tractors as vocational vehicles.[127] The agencies propose in Phase 2 to continue to allow manufacturers to exclude certain vocational-types of tractors from the combination tractor standards and instead be subject to the vocational vehicle standards. However, the agencies propose to set unique standards for tractors used in heavy haul applications in Phase 2. Details regarding the proposed heavy-haul standards are included below in Section II.D.3.

During the development of Phase 1, the agencies received multiple comments from several stakeholders supporting an approach for an alternative treatment of a subset of tractors because they were designed to operate at lower speeds, in stop and go traffic, and sometimes operate at higher weights than the typical line-haul tractor. These types of applications have limited potential for improvements in aerodynamic performance to reduce CO_2 emissions and fuel consumption. Consistent with the agencies' approach in Phase 1, the agencies agree that these vocational tractors are operated differently than line-haul tractors and therefore fit more appropriately into the vocational vehicle category. However, we need to continue to ensure that only tractors that are *truly* vocational tractors are classified as such.[128] A vehicle determined by the manufacturer to be a HHD vocational tractor would fall into one of the HHD vocational vehicle subcategories and be regulated as a vocational vehicle. Similarly, MHD tractors which the manufacturer chooses to reclassify as vocational tractors would be regulated as a MHD vocational vehicle. Specifically, the agencies are proposing to change the provisions in EPA's 40 CFR 1037.630 and NHTSA's regulation at 49 CFR 523.2 and only allow the following two types of vocational tractors to be eligible for reclassification by the manufacturer:

(1) Low-roof tractors intended for intra-city pickup and delivery, such as those that deliver bottled beverages to retail stores.

(2) Tractors intended for off-road operation (including mixed service operation), such as those with reinforced frames and increased ground clearance.[129]

Because the difference between some vocational tractors and line-haul tractors is potentially somewhat subjective, we are also proposing to continue to limit the use of this provision to a rolling three year sales limit of 21,000 vocational tractors per manufacturer consistent with past production volumes of such vehicles. We propose to carry-over the existing three year sales limit with the recognition that heavy-haul tractors would no longer be permitted to be treated as vocational vehicles (suggesting a lower volumetric cap could be appropriate) but that the heavy-duty market has improved since the development of the HD Phase 1 rule (suggesting the need for a higher sales cap). The agencies welcome comment on whether the proposed sales volume limit is set at an appropriate level looking into the future.

Also in Phase 1, EPA determined that manufacturers that met the small business criteria specified in 13 CFR 121.201 for ''Heavy Duty Truck Manufacturing'' were not subject to the greenhouse gas emissions standards of 40 CFR 1037.106.[130] The regulations required that qualifying manufacturers must notify the Designated Compliance Officer each model year before introducing the vehicles into commerce. The manufacturers are also required to label the vehicles to identify them as excluded vehicles. EPA and NHTSA are seeking comments on eliminating this provision for tractor manufacturers in the Phase 2 program. The agencies are aware of two second stage manufacturers building custom sleeper cab tractors. We could treat these vehicles in one of two ways. First, the vehicles may be considered as dromedary vehicles and therefore treated as vocational vehicles.[131] Or the

[125] California Air Resources Board. Staff Report: Initial Statement of Reasons; Notice of Public Hearing to Consider Requirements to Reduce Idling Emissions From New and In-Use Trucks, Beginning in 2008. September 1, 2005. Page 38. Last viewed on October 20, 2014 at *http://www.arb.ca.gov/regact/hdvidle/isor.pdf*.

[126] Proventia. Tripac Filter Kits. Last accessed on October 21, 2014 at *http://www.proventiafilters.com/purchase.html*.

[127] See 40 CFR 1037.630.

[128] As a part of the end of the year compliance process, EPA and NHTSA verify manufacturer's production reports to avoid any abuse of the vocational tractor allowance.

[129] See existing 40 CFR 1037.630(a)(1)(i) through (iii).

[130] See 40 CFR 1037.150(c).

[131] A dromedary is a box, deck, or plate mounted behind the tractor cab and forward of the fifth wheel on the frame of the power unit of a tractor-trailer combination to carry freight.

agencies could provide provisions that stated if a manufacturer changed the cab, but not the frontal area of the vehicle, then it could retain the aerodynamic bin of the original tractor. We welcome comments on these considerations.

EPA is proposing to not exempt glider kits from the Phase 2 GHG emission standards.[132] Gliders and glider kits are exempt from NHTSA's Phase 1 fuel consumption standards. For EPA purposes, the CO_2 provisions of Phase 1 exempted gliders and glider kits produced by small businesses but did not include such a blanket exemption for other glider kits.[133] Thus, some gliders and glider kits are already subject to the requirement to obtain a vehicle certificate prior to introduction into commerce as a new vehicle. However, the agencies believe glider manufacturers may not understand how these regulations apply to them, resulting in a number of uncertified vehicles.

EPA is concerned about adverse economic impacts on small businesses that assemble glider kits and glider vehicles. Therefore, EPA is proposing an option that would grandfather existing small businesses, but cap annual production based on their recent sales. EPA requests comment on whether any special provisions would be needed to accommodate glider kits. See Section XIV for additional discussion of the proposed requirements for glider vehicles.

Similarly, NHTSA is considering including glider vehicles under its Phase 2 program. The agencies request comment on their respective considerations.

We believe that the agencies potentially having different policies for glider kits and glider vehicles under the Phase 2 program would not result in problematic disharmony between the NHTSA and EPA programs, because of the small number of vehicles that would be involved. EPA believes that its proposed changes would result in the glider market returning to the pre-2007 levels, in which fewer than 1,000 glider vehicles would be produced in most years. Only non-exempt glider vehicles would be subject to different requirements under the NHTSA and EPA regulations. However, we believe that this is unlikely to exceed a few hundred vehicles in any year, which would be few enough not to result in any meaningful disharmony between the two agencies.

With regard to NHTSA's safety authority over gliders, the agency notes that it has become increasingly aware of potential noncompliance with its regulations applicable to gliders. NHTSA has learned of manufacturers who are creating glider vehicles that are new vehicles under 49 CFR 571.7(e); however, the manufacturers are not certifying them and obtaining a new VIN as required. NHTSA plans to pursue enforcement actions as applicable against noncompliant manufacturers. In addition to enforcement actions, NHTSA may consider amending 49 CFR 571.7(e) and related regulations as necessary. NHTSA believes manufacturers may not be using this regulation as originally intended.

(5) In-Use Standards

Section 202(a)(1) of the CAA specifies that EPA is to propose emissions standards that are applicable for the useful life of the vehicle. The in-use Phase 2 standards that EPA is proposing would apply to individual vehicles and engines, just as EPA adopted for Phase 1. NHTSA is also proposing to use the same useful life mileage and years as EPA for Phase 2.

EPA is also not proposing any changes to provisions requiring that the useful life for tractors with respect to CO_2 emissions be equal to the respective useful life periods for criteria pollutants, as shown below in Table III–4. See 40 CFR 1037.106(e). EPA does not expect degradation of the technologies evaluated for Phase 2 in terms of CO_2 emissions, therefore we propose no changes to the regulations describing compliance with GHG pollutants with regards to deterioration. See 40 CFR 1037.241. We welcome comments that highlight a need to change this approach.

TABLE III–4—TRACTOR USEFUL LIFE PERIODS

	Years	Miles
Class 7 Tractors	10	185,000
Class 8 Tractors	10	435,000

D. Feasibility of the Proposed Tractor Standards

This section describes the agencies' technical feasibility and cost analysis in greater detail. Further detail on all of these technologies can be found in the draft RIA Chapter 2.

Class 7 and 8 tractors are used in combination with trailers to transport freight. The variation in the design of these tractors and their typical uses drive different technology solutions for each regulatory subcategory. As noted above, the agencies are proposing to continue the Phase 1 provisions that treat vocational tractors as vocational vehicles instead of as combination tractors, as noted in Section III.C. The focus of this section is on the feasibility of the proposed standards for combination tractors including the heavy-haul tractors, but not the vocational tractors.

EPA and NHTSA collected information on the cost and effectiveness of fuel consumption and CO_2 emission reducing technologies from several sources. The primary sources of information were the Southwest Research Institute evaluation of heavy-duty vehicle fuel efficiency and costs for NHTSA,[134] the Department of Energy's SuperTruck Program,[135] 2010 National Academy of Sciences report of Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,[136] TIAX's assessment of technologies to support the NAS panel report,[137] the analysis conducted by the Northeast States Center for a Clean Air Future, International Council on Clean Transportation, Southwest Research Institute and TIAX for reducing fuel consumption of heavy-duty long haul combination tractors (the NESCCAF/ICCT study),[138] and the technology cost analysis conducted by ICF for EPA.[139]

[132] Glider vehicles are new vehicles produced to accept rebuilt engines (or other used engines) along with used axles and/or transmissions. The common commercial term ''glider kit'' is used here primarily to refer to an assemblage of parts into which the used/rebuilt engine is installed.

[133] Rebuilt engines used in glider vehicles are subject to EPA criteria pollutant emission standards applicable for the model year of the engine. See 40 CFR 86.004–40 for requirements that apply for engine rebuilding. Under existing regulations, engines that remain in their certified configuration after rebuilding may continue to be used.

[134] Reinhart, T.E. (June 2015). *Commercial Medium- and Heavy-Duty Truck Fuel Efficiency Technology Study—Report #1.* (Report No. DOT HS 812 146). Washington, DC: National Highway Traffic Safety Administration.

[135] U.S. Department of Energy. SuperTruck Initiative. Information available at *http://energy.gov/eere/vehicles/vehicle-technologies-office.*

[136] Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles; National Research Council; Transportation Research Board (2010). Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles. (''The 2010 NAS Report'') Washington, DC, The National Academies Press.

[137] TIAX, LLC. ''Assessment of Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles,'' Final Report to National Academy of Sciences, November 19, 2009.

[138] NESCCAF, ICCT, Southwest Research Institute, and TIAX. Reducing Heavy-Duty Long Haul Combination Truck Fuel Consumption and CO_2 Emissions. October 2009.

[139] ICF International. ''Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for

Continued

(1) What technologies did the agencies consider to reduce the CO_2 emissions and fuel consumption of combination tractors?

Manufacturers can reduce CO_2 emissions and fuel consumption of combination tractors through use of many technologies, including engine, drivetrain, aerodynamic, tire, extended idle, and weight reduction technologies. The agencies' determination of the feasibility of the proposed HD Phase 2 standards is based on our projection of the use of these technologies and an assessment of their effectiveness. We will also discuss other technologies that could potentially be used, such as vehicle speed limiters, although we are not basing the proposed standards on their use for the model years covered by this proposal, for various reasons discussed below.

In this section we discuss generally the tractor and engine technologies that the agencies considered to improve performance of heavy-duty tractors, while Section III.D.2 discusses the baseline tractor definition and technology packages the agencies used to determine the proposed standard levels.

Engine technologies: As discussed in Section II.D above, there are several engine technologies that can reduce fuel consumption of heavy-duty tractors. These technologies include friction reduction, combustion system optimization, and Rankine cycle. These engine technologies would impact the Phase 2 vehicle results because the agencies propose that the manufacturers enter a fuel map into GEM.

Aerodynamic technologies: There are opportunities to reduce aerodynamic drag from the tractor, but it is sometimes difficult to assess the benefit of individual aerodynamic features. Therefore, reducing aerodynamic drag requires optimizing of the entire system. The potential areas to reduce drag include all sides of the truck—front, sides, top, rear and bottom. The grill, bumper, and hood can be designed to minimize the pressure created by the front of the truck. Technologies such as aerodynamic mirrors and fuel tank fairings can reduce the surface area perpendicular to the wind and provide a smooth surface to minimize disruptions of the air flow. Roof fairings provide a transition to move the air smoothly over the tractor and trailer. Side extenders can minimize the air entrapped in the gap between the tractor and trailer. Lastly, underbelly treatments can manage the flow of air underneath the tractor. DOE has partnered with the heavy-duty industry to demonstrate vehicles that achieve a 50 percent improvement in freight efficiency. This SuperTruck program has led to significant advancements in the aerodynamics of combination tractor-trailers. The manufacturers' SuperTruck demonstration vehicles are achieving approximately 7 percent freight efficiency improvements over a 2010 MY baseline vehicle due to improvements in tractor aerodynamics.[140] The 2010 NAS Report on heavy-duty trucks found that aerodynamic improvements which yield 3 to 4 percent fuel consumption reduction or 6 to 8 percent reduction in Cd values, beyond technologies used in today's SmartWay trucks are achievable.[141]

Lower Rolling Resistance Tires: A tire's rolling resistance results from the tread compound material, the architecture and materials of the casing, tread design, the tire manufacturing process, and its operating conditions (surface, inflation pressure, speed, temperature, etc.). Differences in rolling resistance of up to 50 percent have been identified for tires designed to equip the same vehicle. Since 2007, SmartWay designated tractors have had steer tires with rolling resistance coefficients of less than 6.6 kg/metric ton for the steer tire and less than 7.0 kg/metric ton for the drive tire.[142] Low rolling resistance (LRR) drive tires are currently offered in both dual assembly and wide-based single configurations. Wide based single tires can offer rolling resistance reduction along with improved aerodynamics and weight reduction. The lowest rolling resistance value submitted for 2014MY GHG and fuel efficiency certification was 4.3 and 5.0 kg/metric ton for the steer and drive tires respectively.[143]

Weight Reduction: Reductions in vehicle mass lower fuel consumption and GHG emissions by decreasing the overall vehicle mass that is moved down the road. Weight reductions also increase vehicle payload capability which can allow additional tons to be carried by fewer trucks consuming less fuel and producing lower emissions on a ton-mile basis. We treated such weight reduction in two ways in Phase 1 to account for the fact that combination tractor-trailers weigh-out approximately one-third of the time and cube-out approximately two-thirds of the time. Therefore in Phase 1 and also as proposed for Phase 2, one-third of the weight reduction would be added payload in the denominator while two-thirds of the weight reduction is subtracted from the overall weight of the vehicle in GEM. See 76 FR 57153.

In Phase 1, we reflected mass reductions for specific technology substitutions (*e.g.,* installing aluminum wheels instead of steel wheels). These substitutions were included where we could with confidence verify the mass reduction information provided by the manufacturer. The agencies propose to expand the list of weight reduction components which can be input into GEM in order to provide the manufacturers with additional means to comply via GEM with the combination tractor standards and to further encourage reductions in vehicle weight. As in Phase 1, we recognize that there may be additional potential for weight reduction in new high strength steel components which combine the reduction due to the material substitution along with improvements in redesign, as evidenced by the studies done for light-duty vehicles.[144] In the development of the high strength steel component weights, we are only assuming a reduction from material substitution and no weight reduction from redesign, since we do not have any data specific to redesign of heavy-duty components nor do we have a regulatory mechanism to differentiate between material substitution and improved design. Additional weight reduction would be evaluated as a potential off-cycle credit.

Extended Idle Reduction: Auxiliary power units (APU), fuel operated heaters, battery supplied air conditioning, and thermal storage systems are among the technologies available today to reduce main engine extended idling from sleeper cabs. Each of these technologies reduces fuel consumption during idling from a truck without this equipment (the baseline) from approximately 0.8 gallons per hour (main engine idling fuel consumption rate) to approximately 0.2 gallons per hour for an APU.[145] EPA and NHTSA agree with the TIAX assessment that a 5 percent reduction in overall fuel consumption reduction is achievable.[146]

Heavy-Duty On-Road Vehicles.'' July 2010. Docket Number EPA–HQ–OAR–2010–0162–0283.

[140] Daimler Truck North America. SuperTruck Program Vehicle Project Review. June 19, 2014.

[141] *See* TIAX, Note 137, Page 4–40.

[142] Ibid.

[143] Memo to Docket. Coefficient of Rolling Resistance Certification Data. See Docket EPA–HQ–OAR–2014–0827.

[144] American Iron and Steel Institute. ''A Cost Benefit Analysis Report to the North American Steel Industry on Improved Material and Powertrain Architectures for 21st Century Trucks.''

[145] *See* the draft RIA Chapter 2.4.8 for details.

[146] *See* the 2010 NAS Report, Note 136, above, at 128.

Idle Reduction: Day cab tractors often idle while cargo is loaded or unloaded, as well as during the frequent stops that are inherent with driving in urban traffic conditions near cargo destinations. To recognize idle reduction technologies that reduce workday idling, the agencies have developed a new idle-only duty cycle that is proposed to be used in GEM. As discussed above in Section II.D, this new proposed certification test cycle would measure the amount of fuel saved and CO_2 emissions reduced by two primary types of technologies: Neutral idle and stop-start. The proposed rules apply this test cycle only to vocational vehicles because these types of vehicles spend more time at idle than tractors. However, the agencies request comment on whether we should extend this vocational vehicle idle reduction approach to day cab tractors. Neutral idle would only be available for tractors using torque-converter automatic transmissions, and stop-start would be available for any tractor. Unlike the fixed numerical value in GEM for automatic engine shutdown systems to reduce overnight idling of combination tractors, this new idle reduction approach would result in different numerical values depending on user inputs. The required inputs and other details about this cycle, as it would apply to vocational vehicles, are described in the draft RIA Chapter 3. If we extended this approach to day cab tractors, we could set a fixed GEM composite cycle weighting factor at a value representative of the time spent at idle for a typical day cab tractor, possibly five percent. Under this approach, tractor manufacturers would be able to select GEM inputs that identify the presence of workday idle reduction technologies, and GEM would calculate the associated benefit due to these technologies, using this new idle-only cycle as described in the draft RIA Chapter 3.

The agencies have also received a letter from the California Air Resources Board requesting consideration of credits for reducing solar loads. Solar reflective paints and solar control glazing technologies are briefly discussed in draft RIA Chapter 2.4.9.3. The agencies request comment on the Air Resources Board's letter and recommendations.[147]

Vehicle Speed Limiters: Fuel consumption and GHG emissions increase proportional to the square of vehicle speed. Therefore, lowering vehicle speeds can significantly reduce fuel consumption and GHG emissions. A vehicle speed limiter (VSL), which limits the vehicle's maximum speed, is another technology option for compliance that is already utilized today by some fleets (though the typical maximum speed setting is often higher than 65 mph).

Downsized Engines and Downspeeding: As tractor manufacturers continue to reduce the losses due to vehicle loads, such as aerodynamic drag and rolling resistance, the amount of power required to move the vehicle decreases. In addition, engine manufacturers continue to improve the power density of heavy-duty engines through means such as reducing the engine friction due to smaller surface area. These two changes lead to the ability for truck purchasers to select lower displacement engines while maintaining the previous level of performance. Engine downsizing could be more effective if it is combined with the downspeeding assuming increased BMEP does not affect durability. The increased efficiency of the vehicle moves the operating points down to a lower load zone on a fuel map, which often moves the engine away from its sweet spot to a less efficient zone. In order to compensate for this loss, downspeeding allows the engine to run at a lower engine speed and move back to higher load zones, thus can slightly improve fuel efficiency. Reducing the engine size allows the vehicle operating points to move back to the sweet spot, thus further improving fuel efficiency. Engine downsizing can be accounted for as a vehicle technology through the use of the engine's fuel map in GEM.

Transmission: As discussed in the 2010 NAS report, automatic (AT) and automated manual transmissions (AMT) may offer the ability to improve vehicle fuel consumption by optimizing gear selection compared to an average driver.[148] However, as also noted in the report and in the supporting TIAX report, the improvement is very dependent on the driver of the truck, such that reductions ranged from 0 to 8 percent.[149] Well-trained drivers would be expected to perform as well or even better than an automatic transmission since the driver can see the road ahead and anticipate a changing stoplight or other road condition that neither an automatic nor automated manual transmission can anticipate. However, poorly-trained drivers that shift too frequently or not frequently enough to maintain optimum engine operating conditions could be expected to realize improved in-use fuel consumption by switching from a manual transmission to an automatic or automated manual transmission. As transmissions continue to evolve, we are now seeing in the European heavy-duty vehicle market the addition of dual clutch transmissions (DCT). DCTs operate similar to AMTs, but with two clutches so that the transmission can maintain engine speed during a shift which improves fuel efficiency. We believe there may be real benefits in reduced fuel consumption and GHG emissions through the adoption of dual clutch, automatic or automated manual transmission technology.

Low Friction Transmission, Axle, and Wheel Bearing Lubricants: The 2010 NAS report assessed low friction lubricants for the drivetrain as providing a 1 percent improvement in fuel consumption based on fleet testing.[150] A field trial of European medium-duty trucks found an average fuel consumption improvement of 1.8 percent using SAE 5W–30 engine oil, SAE 75W90 axle oil and SAE 75W80 transmission oil when compared to SAE 15W40 engine oil and SAE 90W axle oil, and SAE 80W transmission oil.[151] The light-duty 2012–16 MY vehicle rule and the pickup truck portion of this program estimate that low friction lubricants can have an effectiveness value between 0 and 1 percent compared to traditional lubricants.

Drivetrain: Most tractors today have three axles—a steer axle and two rear drive axles, and are commonly referred to as 6x4 tractors. Manufacturers offer 6x2 tractors that include one rear drive axle and one rear non-driving axle. The 6x2 tractors offer three distinct benefits. First, the non-driving rear axle does not have internal friction and therefore reduces the overall parasitic losses in the drivetrain. In addition, the 6x2 configuration typically weighs approximately 300 to 400 lbs less than

[147] California Air Resources Board. Letter from Michael Carter to Matthew Spears dated December 3, 2014. Solar Control: Heavy-Duty Vehicles White Paper. Docket EPA–HA–OAR–2014–0827.

[148] Manual transmissions require the driver to shift the gears and manually engage and disengage the clutch. Automatic transmissions shift gears through computer controls and typically include a torque converter. An AMT operates similar to a manual transmission, except that an automated clutch actuator disengages and engages the drivetrain instead of a human driver. An AMT does not include a clutch pedal controllable by the driver or a torque converter.

[149] *See* TIAX, Note 137, above at 4–70.

[150] *See* the 2010 NAS Report, Note 136, page 67.

[151] Green, D.A., et al. ''The Effect of Engine, Axle, and Transmission Lubricant, and Operating Conditions on Heavy Duty Diesel Fuel Economy. Part 1: Measurements.'' SAE 2011–01–2129. SAE International Journal of Fuels and Lubricants. January 2012.

a 6x4 configuration.[152] Finally, the 6x2 typically costs less or is cost neutral when compared to a 6x4 tractor. Sources cite the effectiveness of 6x2 axles at between 1 and 3 percent.[153] Similarly, with the increased use of double and triple trailers, which reduce the weight on the tractor axles when compared to a single trailer, manufacturers offer 4x2 axle configurations. The 4x2 axle configuration would have as good as or better fuel efficiency performance than a 6x2.

Accessory Improvements: Parasitic losses from the engine come from many systems, including the water pump, oil pump, and power steering pump. Reductions in parasitic losses are one of the areas being developed under the DOE SuperTruck program. As presented in the DOE Merit reviews, Navistar stated that they demonstrated a 0.45 percent reduction in fuel consumption through water pump improvements and 0.3 percent through oil pump improvements compared to a current engine. In addition, Navistar showed a 0.9 percent benefit for a variable speed water pump and variable displacement oil pump. Detroit Diesel reports a 0.5 percent coming from improved water pump efficiency.[154] It should be noted that water pump improvements include both pump efficiency improvement and variable speed or on/off controls. Lube pump improvements are primarily achieved using variable displacement pumps and may also include efficiency improvement. All of these results shown in this paragraph are demonstrated through the DOE SuperTruck program at single operating point on the engine map, and therefore the overall expected reduction of these technologies is less than the single point result.

Intelligent Controls: Skilled drivers know how to control a vehicle to obtain maximum fuel efficiency by, among other things, considering road terrain. For example, the driver may allow the vehicle to slow down below the target speed on an uphill and allow it to go over the target speed when going downhill, to essentially smooth out the engine demand. Electronic controls can be developed to essentially mimic this activity. The agencies propose to provide a 2 percent reduction in fuel consumption and CO_2 emissions for vehicles configured with intelligent controls, such as predictive cruise control.

Automatic Tire Inflation Systems: Proper tire inflation is critical to maintaining proper stress distribution in the tire, which reduces heat loss and rolling resistance. Tires with reduced inflation pressure exhibit a larger footprint on the road, more sidewall flexing and tread shearing, and therefore, have greater rolling resistance than a tire operating at its optimal inflation pressure. Bridgestone tested the effect of inflation pressure and found a 2 percent variation in fuel consumption over a 40 psi range.[155] Generally, a 10 psi reduction in overall tire inflation results in about a 1 percent reduction in fuel economy.[156] To achieve the intended fuel efficiency benefits of low rolling resistance tires, it is critical that tires are maintained at the proper inflation pressure.

Proper tire inflation pressure can be maintained with a rigorous tire inspection and maintenance program or with the use of tire pressure and inflation systems. According to a study conducted by FMCSA in 2003, about 1 in 5 tractors/trucks is operating with 1 or more tires underinflated by at least 20 psi.[157] A 2011 FMCSA study estimated underinflation accounts for one service call per year and increases tire procurement costs 10 to 13 percent. The study found that total operating costs can increase by $600 to $800 per year due to underinflation.[158] A recent study by The North American Council on Freight Efficiency, found that adoption of tire pressure monitoring systems is increasing. It also found that reliability and durability of commercially available tire pressure systems are good and early issues with the systems have been addressed.[159] These automatic tire inflation systems monitor tire pressure and also automatically keep tires inflated to a specific level. The agencies propose to provide a 1 percent CO_2 and fuel consumption reduction value for tractors with automatic tire inflation systems installed.

Tire pressure monitoring systems notify the operator of tire pressure, but require the operator to manually inflate the tires to the optimum pressure. Because of the dependence on the operator's action, the agencies are not proposing to provide a reduction value for tire pressure monitoring systems. We request comment on this approach and seek data from those that support a reduction value be assigned to tire pressure monitoring systems.

Hybrid: Hybrid powertrain development in Class 7 and 8 tractors has been limited to a few manufacturer demonstration vehicles to date. One of the key benefit opportunities for fuel consumption reduction with hybrids is less fuel consumption when a vehicle is idling, but the standard is already premised on use of extended idle reduction so use of hybrid technology would duplicate many of the same emission reductions attributable to extended idle reduction. NAS estimated that hybrid systems would cost approximately $25,000 per tractor in the 2015 through the 2020 time frame and provide a potential fuel consumption reduction of 10 percent, of which 6 percent is idle reduction which can be achieved (less expensively) through the use of other idle reduction technologies.[160] The limited reduction potential outside of idle reduction for Class 8 sleeper cab tractors is due to the mostly highway operation and limited start-stop operation. Due to the high cost and limited benefit during the model years at issue in this action (as well as issues regarding sufficiency of lead time (see Section III.D.2 below), the agencies are not including hybrids in assessing standard stringency (or as an input to GEM).

Management: The 2010 NAS report noted many operational opportunities to reduce fuel consumption, such as driver training and route optimization. The agencies have included discussion of several of these strategies in draft RIA Chapter 2, but are not using these approaches or technologies in the standard setting process. The agencies are looking to other resources, such as EPA's SmartWay Transport Partnership and regulations that could potentially be promulgated by the Federal Highway Administration and the Federal Motor Carrier Safety Administration, to continue to encourage the development and utilization of these approaches.

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[152] North American Council for Freight Efficiency. "Confidence Findings on the Potential of 6x2 Axles." 2014. Page 16.

[153] Reinhart, T.E. (June 2015). *Commercial Medium- and Heavy-Duty Truck Fuel Efficiency Technology Study—Report #1.* (Report No. DOT HS 812 146). Washington, DC: National Highway Traffic Safety Administration.

[154] *See* the draft RIA Chapter 2.4 for details.

[155] Bridgestone Tires. Real Questions, Real Answers. *http://www.bridgestonetrucktires.com/us_eng/real/magazines/ra_special-edit_4/ra_special4_fuel-tires.asp.*

[156] "Factors Affecting Truck Fuel Economy," Goodyear, Radial Truck and Retread Service Manual. Accessed February 16, 2010 at *http://www.goodyear.com/truck/pdf/radialretserv/Retread_S9_V.pdf.*

[157] American Trucking Association. Tire Pressure Monitoring and Inflation Maintenance. June 2010. Page 3. Last accessed on December 15, 2014 at *http://www.trucking.org/ATA%20Docs/About/Organization/TMC/Documents/Position%20Papers/Study%20Group%20Information%20Reports/Tire%20Pressure%20Monitoring%20and%20Inflation%20Maintenance%E2%80%94TMC%20I.R.%202010-2.pdf.*

[158] TMC Future Truck Committee Presentation "FMCSA Tire Pressure Monitoring Field Operational Test Results," February 8, 2011.

[159] North American Council for Freight Efficiency, "Tire Pressure Systems," 2013.

[160] *See* the 2010 NAS Report, Note 136, page 128.

(2) Projected Technology Effectiveness and Cost

EPA and NHTSA project that CO_2 emissions and fuel consumption reductions can be feasibly and cost-effectively met through technological improvements in several areas. The agencies evaluated each technology and estimated the most appropriate adoption rate of technology into each tractor subcategory. The next sections describe the baseline vehicle configuration, the effectiveness of the individual technologies, the costs of the technologies, the projected adoption rates of the technologies into the regulatory subcategories, and finally the derivation of the proposed standards.

The agencies propose Phase 2 standards that project by 2027, all high-roof tractors would have aerodynamic performance equal to or better today's SmartWay performance—which represents the best of today's technology. This would equate to having 40 percent of new high roof sleeper cabs in 2027 complying with the current best practices and 60 percent of the new high-roof sleeper cab tractors sold in 2027 having better aerodynamic performance than the best tractors available today. For tire rolling resistance, we premised the proposed standards on the assumption that nearly all tires in 2027 would have rolling resistance equal to or superior to tires meeting today's SmartWay designation. As discussed in Section II.D, the agencies assume the proposed 2027 MY engines would achieve an additional 4 percent improvement over Phase 1 engines and we project would include 15 percent of waste heat recovery (WHR) and many other advanced engine technologies. In addition, we are proposing standards that project improvements to nearly all of today's transmissions, incorporation of extended idle reduction technologies on 90 percent of sleeper cabs, and significant adoption of other types of technologies such as predictive cruise control and automatic tire inflation systems.

In addition to the high cost and limited utility of hybrids for many tractor drive cycles noted above, the agencies believe that hybrid powertrains systems for tractors may not be sufficiently developed and the necessary manufacturing capacity put in place to base a standard on any significant volume of hybrid tractors. Unlike hybrids for vocational vehicles and light-duty vehicles, the agencies are not aware of any full hybrid systems currently developed for long haul tractor applications. To date, hybrid systems for tractors have been primarily focused on idle shutdown technologies and not on the broader energy storage and recovery systems necessary to achieve reductions over typical vehicle drive cycles. The proposed standards reflect the potential for idle shutdown technologies through GEM. Further as highlighted by the 2010 NAS report, the agencies do believe that full hybrid powertrains may have the potential in the longer term to provide significant improvements in tractor fuel efficiency and to greenhouse gas emission reductions. However, due to the high cost, limited benefit during highway driving, and lacking any existing systems or manufacturing base, we cannot conclude with certainty, absent additional information, that such technology would be available for tractors in the 2021–2027 timeframe. However the agencies welcome comment from industry and others on their projected timeline for deployment of hybrid powertrains for tractor applications.

(a) Tractor Baselines for Costs and Effectiveness

The fuel efficiency and CO_2 emissions of combination tractors vary depending on the configuration of the tractor. Many aspects of the tractor impact its performance, including the engine, transmission, drive axle, aerodynamics, and rolling resistance. For each subcategory, the agencies selected a theoretical tractor to represent the average 2017 model year tractor that meets the Phase 1 standards (see 76 FR 57212, September 15, 2011). These tractors are used as baselines from which to evaluate costs and effectiveness of additional technologies and standards. The specific attributes of each tractor subcategory are listed below in Table III–5. Using these values, the agencies assessed the CO_2 emissions and fuel consumption performance of the proposed baseline tractors using the proposed version of Phase 2 GEM. The results of these simulations are shown below in Table III–6.

As noted earlier, the Phase 1 2017 model year tractor standards and the baseline 2017 model year tractor results are not directly comparable. The same set of aerodynamic and tire rolling resistance technologies were used in both setting the Phase 1 standards and determining the baseline of the Phase 2 tractors. However, there are several aspects that differ. First, a new version of GEM was developed and validated to provide additional capabilities, including more refined modeling of transmissions and engines. Second, the determination of the proposed HD Phase 2 CdA value takes into account a revised test procedure, a new standard reference trailer, and wind averaged drag as discussed below in Section III.E. In addition, the proposed HD Phase 2 version of GEM includes road grade in the 55 mph and 65 mph highway cycles, as discussed below in Section III.E. Finally, the agencies assessed the current level of automatic engine shutdown and idle reduction technologies used by the tractor manufacturers to comply with the 2014 model year CO_2 and fuel consumption standards. To date, the manufacturers are meeting the 2014 model year standards without the use of this technology. Therefore, in this proposal the agencies reverted back to the baseline APU adoption rate of 30 percent, the value used in the Phase 1 baseline.

TABLE III–5—GEM INPUTS FOR THE BASELINE CLASS 7 AND 8 TRACTOR

Class 7			Class 8					
Day cab			Day cab			Sleeper cab		
Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
Engine								
2017 MY 11L Engine 350 HP	2017 MY 11L Engine 350 HP	2017 MY 11L Engine 350 HP	2017 MY 15L Engine 455 HP	2017 MY 15L Engine 455 HP	2017 MY 15L Engine 455 HP	2017 MY 15L Engine 455 HP	2017 MY 15L Engine 455 HP	2017 MY 15L Engine 455 HP
Aerodynamics (CdA in m²)								
5.00	6.40	6.42	5.00	6.40	6.42	4.95	6.35	6.22
Steer Tires (CRR in kg/metric ton)								
6.99	6.99	6.87	6.99	6.99	6.87	6.87	6.87	6.54
Drive Tires (CRR in kg/metric ton)								
7.38	7.38	7.26	7.38	7.38	7.26	7.26	7.26	6.92
Extended Idle Reduction Adoption Rate								
N/A	N/A	N/A	N/A	N/A	N/A	30%	30%	30%
Transmission = 10 Speed Manual Transmission								
Gear Ratios = 12.8, 9.25, 6.76, 4.90, 3.58, 2.61, 1.89, 1.38, 1.00, 0.73								
Drive Axle Ratio = 3.70								

TABLE III–6—CLASS 7 AND 8 TRACTOR BASELINE CO_2 EMISSIONS AND FUEL CONSUMPTION

	Class 7			Class 8					
	Day cab			Day cab			Sleeper cab		
	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
CO_2 (grams CO_2/ton-mile)	107	118	121	86	93	95	79	87	88
Fuel Consumption (gal/1,000 ton-mile)	10.5	11.6	11.9	8.4	9.1	9.3	7.8	8.5	8.6

The fuel consumption and CO_2 emissions in the baseline described above remains the same over time with no assumed improvements after 2017, absent a Phase 2 regulation. An alternative baseline was also evaluated by the agencies in which there is a continuing uptake of technologies in the tractor market that reduce fuel consumption and CO_2 emissions absent a Phase 2 regulation. This alternative baseline, referred to as the more dynamic baseline, was developed to estimate the effect of market pressures and non-regulatory government initiatives to improve tractor fuel consumption. The more dynamic baseline assumes that the significant level of research funded and conducted by the Federal government, industry, academia and other organizations will, in the future, result the adoption of some technologies beyond the levels required to comply with Phase 1 standards. One example of such research is the Department of Energy Super Truck program [161] which has a goal of demonstrating cost-effective measures to improve the efficiency of Class 8 long-haul freight trucks by 50 percent by 2015. The more dynamic baseline also assumes that manufacturers will not cease offering fuel efficiency improving technologies that currently have significant market penetration, such as automated manual transmissions. The baselines (one for each of the nine tractor types) are characterized by fuel consumption and CO_2 emissions that gradually decrease between 2019 and 2028. In 2028, the fuel consumption for the alternative tractor baselines is approximately 4.0 percent lower than those shown in Table III–6. This results from the assumed introduction of aerodynamic technologies such as down exhaust, underbody airflow treatment in addition to tires with lower rolling resistance. The assumed introduction of these technologies reduces the CdA of the baseline tractors and CRR of the tractor tires. To take one example, the CdA for baseline high roof sleeper cabs in Table III–5 is 6.22 (m²) in 2018. In 2028, the CdA of a high roof sleeper cab would be assumed to still be 6.22 m² in the baseline case outlined above. Alternatively, in the dynamic baseline, the CdA for high roof sleeper cabs is 5.61 (m²) in 2028 due to assumed market penetration of technologies absent the Phase 2 regulation. The dynamic baseline analysis is discussed in more detail in draft RIA Chapter 11.

[161] U.S. Department of Energy. ''SuperTruck Making Leaps in Fuel Efficiency.'' 2014. Last accessed on May 10, 2015 at *http://energy.gov/eere/articles/supertruck-making-leaps-fuel-efficiency.*

(b) Tractor Technology Packages

The agencies' assessment of the proposed technology effectiveness was developed through the use of the GEM in coordination with modeling conducted by Southwest Research Institute. The agencies developed the proposed standards through a three-step process, similar to the approach used in Phase 1. First, the agencies developed technology performance characteristics for each technology, as described below. Each technology is associated with an input parameter which in turn would be used as an input to the Phase 2 GEM simulation tool and its effectiveness thereby modeled. The performance levels for the range of Class 7 and 8 tractor aerodynamic packages and vehicle technologies are described below in Table III–7. Second, the agencies combined the technology performance levels with a projected technology adoption rate to determine the GEM inputs used to set the stringency of the proposed standards. Third, the agencies input these parameters into Phase 2 GEM and used the output to determine the proposed CO_2 emissions and fuel consumption levels. All percentage improvements noted below are over the 2017 baseline tractor.

(i) Engine Improvements

There are several technologies that could be used to improve the efficiency of diesel engines used in tractors. Details of the engine technologies, adoption rates, and overall fuel consumption and CO_2 emission reductions are included in Section II.D. The proposed heavy-duty tractor engine standards would lead to a 1.5 percent reduction in 2021MY, a 3.5 percent reduction in 2024MY, and a 4 percent reduction in 2027MY. These reductions would show up in the fuel map used in GEM.

(ii) Aerodynamics

The aerodynamic packages are categorized as Bin I, Bin II, Bin III, Bin IV, Bin V, Bin VI, or Bin VII based on the wind averaged drag aerodynamic performance determined through testing conducted by the manufacturer. A more complete description of these aerodynamic packages is included in Chapter 2 of the draft RIA. In general, the proposed CdA values for each package and tractor subcategory were developed through EPA's coastdown testing of tractor-trailer combinations, the 2010 NAS report, and SAE papers.

(iii) Tire Rolling Resistance

The proposed rolling resistance coefficient target for Phase 2 was developed from SmartWay's tire testing to develop the SmartWay certification, testing a selection of tractor tires as part of the Phase 1 and Phase 2 programs, and from 2014 MY certification data. Even though the coefficient of tire rolling resistance comes in a range of values, to analyze this range, the tire performance was evaluated at four levels for both steer and drive tires, as determined by the agencies. The four levels are the baseline (average) from 2010, Level I and Level 2 from Phase 1, and Level 3 that achieves an additional 25 percent improvement over Level 2. The Level 1 rolling resistance performance represents the threshold used to develop SmartWay designated tires for long haul tractors. The Level 2 threshold represents an incremental step for improvements beyond today's SmartWay level and represents the best in class rolling resistance of the tires we tested. The Level 3 values represent the long-term rolling resistance value that the agencies predicts could be achieved in the 2025 timeframe. Given the multiple year phase-in of the standards, the agencies expect that tire manufacturers will continue to respond to demand for more efficient tires and will offer increasing numbers of tire models with rolling resistance values significantly better than today's typical low rolling resistance tires. The tire rolling resistance level assumed to meet the 2017 MY Phase 1 standard high roof sleeper cab is considered to be a weighted average of 10 percent baseline rolling resistance, 70 percent Level 1, and 20 percent Level 2. The tire rolling resistance to meet the 2017MY Phase 1 standards for the high roof day cab, low roof sleeper cab, and mid roof sleeper cab includes 30 percent baseline, 60 percent Level 1 and 10 percent Level 2. Finally, the low roof day cab 2017MY standard can be met with a weighted average rolling resistance consisting of 40 percent baseline, 50 percent Level 1, and 10 percent Level 2.

(iv) Idle Reduction

The benefits for the extended idle reductions were developed from literature, SmartWay work, and the 2010 NAS report. Additional details regarding the comments and calculations are included in draft RIA Section 2.4.

(v) Transmission

The benefits for automated manual, automatic, and dual clutch transmissions were developed from literature and from simulation modeling conducted by Southwest Research Institute. The benefit of these transmissions is proposed to be set to a two percent improvement over a manual transmission due to the automation of the gear shifting.

(vi) Drivetrain

The reduction in friction due to low viscosity axle lubricants is set to 0.5 percent. 6x4 and 4x2 axle configurations lead to a 2.5 percent improvement in vehicle efficiency. Downspeeding would be as demonstrated through the Phase 2 GEM inputs of transmission gear ratio, drive axle ratio, and tire diameter. Downspeeding is projected to improve the fuel consumption by 1.8 percent.

(vii) Accessories and Other Technologies

Compared to 2017MY air conditioners, air conditioners with improved efficiency compressors will reduce CO_2 emissions by 0.5 percent. Improvements in accessories, such as power steering, can lead to an efficiency improvement of 1 percent over the 2017MY baseline. Based on literature information, intelligent controls such as predictive cruise control will reduce CO_2 emissions by 2 percent while automatic tire inflation systems improve fuel consumption by 1 percent by keeping tire rolling resistance to its optimum based on inflation pressure.

(viii) Weight Reduction

The weight reductions were developed from tire manufacturer information, the Aluminum Association, the Department of Energy, SABIC and TIAX, as discussed above in Section II.B.3.e.

(ix) Vehicle Speed Limiter

The agencies did not consider the availability of vehicle speed limiter technology in setting the Phase 1 stringency levels, and again did not consider the availability of the technology in developing regulatory alternatives for Phase 2. However, as described in more detail above, speed limiters could be an effective means for achieving compliance, if employed on a voluntary basis.

(x) Summary of Technology Performance

Table III–7 describes the performance levels for the range of Class 7 and 8 tractor vehicle technologies.

TABLE III–7—PROPOSED PHASE 2 TECHNOLOGY INPUTS

	Class 7			Class 8					
	Day cab			Day cab			Sleeper cab		
	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
Engine									
	2021MY 11L Engine 350 HP	2021MY 11L Engine 350 HP	2021MY 11L Engine 350 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP
Aerodynamics (CdA in m²)									
Bin I	5.3	6.7	7.6	5.3	6.7	7.6	5.3	6.7	7.4
Bin II	4.8	6.2	7.1	4.8	6.2	7.1	4.8	6.2	6.9
Bin III	4.3	5.7	6.5	4.3	5.7	6.5	4.3	5.7	6.3
Bin IV	4.0	5.4	5.8	4.0	5.4	5.8	4.0	5.4	5.6
Bin V	N/A	N/A	5.3	N/A	N/A	5.3	N/A	N/A	5.1
Bin VI	N/A	N/A	4.9	N/A	N/A	4.9	N/A	N/A	4.7
Bin VII	N/A	N/A	4.5	N/A	N/A	4.5	N/A	N/A	4.3
Steer Tires (CRR in kg/metric ton)									
Base	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Level 1	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Level 2	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Level 3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Drive Tires (CRR in kg/metric ton)									
Base	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Level 1	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Level 2	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Level 3	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Idle Reduction (% reduction)									
APU	N/A	N/A	N/A	N/A	N/A	N/A	5%	5%	5%
Other	N/A	N/A	N/A	N/A	N/A	N/A	7%	7%	7%
Transmission Type (% reduction)									
Manual	0%	0%	0%	0%	0%	0%	0%	0%	0%
AMT	2	2	2	2	2	2	2	2	2
Auto	2	2	2	2	2	2	2	2	2
Dual Clutch	2	2	2	2	2	2	2	2	2
Driveline (% reduction)									
Axle Lubricant	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
6×2 or 4×2 Axle	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Downspeed	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Accessory Improvements (% reduction)									
A/C	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Electric Access	1	1	1	1	1	1	1	1	1
Other Technologies (% reduction)									
Predictive Cruise Control	2%	2%	2%	2%	2%	2%	2%	2%	2%
Automated Tire Inflation System	1	1	1	1	1	1	1	1	1

(c) Tractor Technology Adoption Rates

As explained above, tractor manufacturers often introduce major product changes together, as a package. In this manner the manufacturers can optimize their available resources, including engineering, development, manufacturing and marketing activities to create a product with multiple new features. In addition, manufacturers recognize that a truck design will need to remain competitive over the intended life of the design and meet future regulatory requirements. In some limited cases, manufacturers may implement an individual technology outside of a vehicle's redesign cycle.

With respect to the levels of technology adoption used to develop the proposed HD Phase 2 standards, NHTSA and EPA established technology adoption constraints. The first type of constraint was established based on the application of fuel consumption and CO_2 emission reduction technologies into the different types of tractors. For example, extended idle reduction technologies are limited to Class 8 sleeper cabs using the reasonable assumption that day cabs are not used for overnight hoteling. A second type of constraint was applied to most other technologies and limited their adoption based on factors reflecting the real world operating conditions that some combination tractors encounter. This second type of constraint was applied to the aerodynamic, tire, powertrain, and vehicle speed limiter technologies.

Table III–8 and Table III–10, specify the adoption rates that EPA and NHTSA used to develop the proposed standards. The agencies welcome comments on these adoption rates.

NHTSA and EPA believe that within each of these individual vehicle categories there are particular applications where the use of the identified technologies would be either ineffective or not technically feasible. For example, the agencies are not predicating the proposed standards on the use of full aerodynamic vehicle treatments on 100 percent of tractors because we know that in many applications (for example gravel truck engaged in local aggregate delivery) the added weight of the aerodynamic technologies will increase fuel consumption and hence CO_2 emissions to a greater degree than the reduction that would be accomplished from the more aerodynamic nature of the tractor.

(i) Aerodynamics Adoption Rate

The impact of aerodynamics on a tractor-trailer's efficiency increases with vehicle speed. Therefore, the usage pattern of the vehicle will determine the benefit of various aerodynamic technologies. Sleeper cabs are often used in line haul applications and drive the majority of their miles on the highway travelling at speeds greater than 55 mph. The industry has focused aerodynamic technology development, including SmartWay tractors, on these types of trucks. Therefore the agencies are proposing the most aggressive aerodynamic technology application to this regulatory subcategory. All of the major manufacturers today offer at least one SmartWay sleeper cab tractor model, which is represented as Bin III aerodynamic performance. The proposed aerodynamic adoption rate for Class 8 high roof sleeper cabs in 2027 (*i.e.,* the degree of technology adoption on which the stringency of the proposed standard is premised) consists of 20 percent of Bin IV, 35 percent Bin V, 20 percent Bin VI, and 5 percent Bin VII reflecting our assessment of the fraction of tractors in this segment that could successfully apply these aerodynamic packages with this amount of lead time. We believe that there is sufficient lead time to develop aerodynamic tractors that can move the entire high roof sleeper cab aerodynamic performance to be as good as or better than today's SmartWay designated tractors. The changes required for Bin IV and better performance reflect the kinds of improvements projected in the Department of Energy's SuperTruck program. That program assumes that such systems can be demonstrated on vehicles by 2017. In this case, the agencies are projecting that truck manufacturers would be able to begin implementing these aerodynamic technologies as early as 2021 MY on a limited scale. Importantly, our averaging, banking and trading provisions provide manufacturers with the flexibility (and incentive) to implement these technologies over time even though the standard changes in a single step.

The aerodynamic adoption rates used to develop the proposed standards for the other tractor regulatory categories are less aggressive than for the Class 8 sleeper cab high roof. Aerodynamic improvements through new tractor designs and the development of new aerodynamic components is an inherently slow and iterative process. The agencies recognize that there are tractor applications which require on/off-road capability and other truck functions which restrict the type of aerodynamic equipment applicable. We also recognize that these types of trucks spend less time at highway speeds where aerodynamic technologies have the greatest benefit. The 2002 VIUS data ranks trucks by major use.[162] The heavy trucks usage indicates that up to 35 percent of the trucks may be used in on/off-road applications or heavier applications. The uses include construction (16 percent), agriculture (12 percent), waste management (5 percent), and mining (2 percent). Therefore, the agencies analyzed the technologies to evaluate the potential restrictions that would prevent 100 percent adoption of more advanced aerodynamic technologies for all of the tractor regulatory subcategories.

As discussed in Section III.C.2, the agencies propose to increase the number of aerodynamic bins for low and mid roof tractors from the two levels adopted in Phase 1 to four levels in Phase 2. The agencies propose to increase the number of bins for these tractors to reflect the actual range of aerodynamic technologies effective in low and mid roof tractor applications. The aerodynamic improvements to the bumper, hood, windshield, mirrors, and doors are developed for the high roof tractor application and then carried over into the low and mid roof applications.

(ii) Low Rolling Resistance Tire Adoption Rate

For the tire manufacturers to further reduce tire rolling resistance, the manufacturers must consider several performance criteria that affect tire selection. The characteristics of a tire also influence durability, traction control, vehicle handling, comfort, and retreadability. A single performance parameter can easily be enhanced, but an optimal balance of all the criteria will require improvements in materials and tread design at a higher cost, as estimated by the agencies. Tire design requires balancing performance, since changes in design may change different performance characteristics in opposing directions. Similar to the discussion regarding lesser aerodynamic technology application in tractor segments other than sleeper cab high roof, the agencies believe that the proposed standards should not be premised on 100 percent application of Level 3 tires in all tractor segments given the potential interference with vehicle utility that could result.

(iii) Weight Reduction Technology Adoption Rate

Unlike in HD Phase 1, the agencies propose setting the 2021 through 2027 model year tractor standards without using weight reduction as a technology to demonstrate the feasibility. However, as described in Section III.C.2 below, the agencies are proposing an expanded list of weight reduction options which could be input into the GEM by the manufacturers to reduce their certified CO_2 emission and fuel consumption levels. The agencies view weight reduction as a technology with a high cost that offers a small benefit in the tractor sector. For example, our estimate of a 400 pound weight reduction would cost $2,050 (2012$) in 2021MY, but offers a 0.3 percent reduction in fuel consumption and CO_2 emissions.

(iv) Idle Reduction Technology Adoption Rate

Idle reduction technologies provide significant reductions in fuel consumption and CO_2 emissions for Class 8 sleeper cabs and are available on

[162] U.S. Department of Energy. *Transportation Energy Data Book,* Edition 28–2009. Table 5.7.

the market today. There are several different technologies available to reduce idling. These include APUs, diesel fired heaters, and battery powered units. Our discussions with manufacturers indicate that idle technologies are sometimes installed in the factory, but it is also a common practice to have the units installed after the sale of the truck. We would like to continue to incentivize this practice and to do so in a manner that the emission reductions associated with idle reduction technology occur in use. Therefore, as adopted in Phase 1, we are allowing only idle emission reduction technologies which include an automatic engine shutoff (AES) with some override provisions.[163] However, we welcome comment on other approaches that would appropriately quantify the reductions that would be experienced in the real world.

We propose an overall 90 percent adoption rate for this technology for Class 8 sleeper cabs. The agencies are unaware of reasons why AES with extended idle reduction technologies could not be applied to this high fraction of tractors with a sleeper cab, except those deemed a vocational tractor, in the available lead time.

The agencies are interested in extending the idle reduction benefits beyond Class 8 sleepers, to day cabs. The agencies reviewed literature to quantify the amount of idling which is conducted outside of hoteling operations. One study, conducted by Argonne National Laboratory, identified several different types of trucks which might idle for extended amounts of time during the work day.[164] Idling may occur during the delivery process, queuing at loading docks or border crossings, during power take off operations, or to provide comfort during the work day. However, the study provided only ''rough estimates'' of the idle time and energy use for these vehicles. The agencies are not able to appropriately develop a baseline of workday idling for day cabs and identify the percent of this idling which could be reduced through the use of AES. We welcome comment and data on quantifying the effectiveness of AES on day cabs.

(v) Vehicle Speed Limiter Adoption Rate

As adopted in Phase 1, we propose to continue the approach where vehicle speed limiters may be used as a technology to meet the proposed standard. In setting the proposed standard, however, we assumed a zero percent adoption rate of vehicle speed limiters. Although we believe vehicle speed limiters are a simple, easy to implement, and inexpensive technology, we want to leave the use of vehicles speed limiters to the truck purchaser. Since truck fleets purchase tractors today with owner-set vehicle speed limiters, we considered not including VSLs in our compliance model. However, we have concluded that we should allow the use of VSLs that cannot be overridden by the operator as a means of compliance for vehicle manufacturers that wish to offer it and truck purchasers that wish to purchase the technology. In doing so, we are providing another means of meeting that standard that can lower compliance cost and provide a more optimal vehicle solution for some truck fleets or owners. For example, a local beverage distributor may operate trucks in a distribution network of primarily local roads. Under those conditions, aerodynamic fairings used to reduce aerodynamic drag provide little benefit due to the low vehicle speed while adding additional mass to the vehicle. A vehicle manufacturer could choose to install a VSL set at 55 mph for this vehicle at the request of the customer. The resulting tractor would be optimized for its intended application and would be fully compliant with our program all at a lower cost to the ultimate tractor purchaser.[165]

As in Phase 1, we have chosen not to base the proposed standards on performance of VSLs because of concerns about how to set a realistic adoption rate that avoids unintended adverse impacts. Although we expect there would be some use of VSL, currently it is used when the fleet involved decides it is feasible and practicable and increases the overall efficiency of the freight system for that fleet operator. To date, the compliance data provided by manufacturers indicate that none of the tractor configurations include a tamper-proof VSL setting less than 65 mph. At this point the agencies are not in a position to determine in how many additional situations use of a VSL would result in similar benefits to overall efficiency or how many customers would be willing to accept a tamper-proof VSL setting. As discussed in Section III.E.2.f below, we welcome comment on suggestions to modify the tamper-proof requirement while maintaining assurance that the speed limiter is used in-use throughout the life of the vehicle. We are not able at this time to quantify the potential loss in utility due to the use of VSLs, but we welcome comment on whether the use of a VSL would require a fleet to deploy additional tractors. Absent this information, we cannot make a determination regarding the reasonableness of setting a standard based on a particular VSL level. Therefore, the agencies are not premising the proposed standards on use of VSL, and instead would continue to rely on the industry to select VSL when circumstances are appropriate for its use. The agencies have not included either the cost or benefit due to VSLs in analysis of the proposed program's costs and benefits, therefore it remains a significant flexibility for manufacturers to choose.

(vi) Summary of the Adoption Rates Used To Determine the Proposed Standards

Table III–8 through Table III–10 provide the adoption rates of each technology broken down by weight class, cab configuration, and roof height.

[163] The agencies are proposing to continue the HD Phase 1 AES override provisions included in 40 CFR 1037.660(b) for driver safety.

[164] Gaines, L., A. Vyas, J. Anderson. Estimation of Fuel Use by Idling Commercial Trucks. January 2006.

[165] Ibid.

The agencies note that because a VSL value can be input into GEM, its benefits can be directly assessed with the model and off cycle credit applications therefore are not necessary even though the proposed standard is not based on performance of VSLs (*i.e.* VSL is an on-cycle technology).

TABLE III–8—TECHNOLOGY ADOPTION RATES FOR CLASS 7 AND 8 TRACTORS FOR DETERMINING THE PROPOSED 2021 MY STANDARDS

	Class 7			Class 8					
	Day cab			Day Cab			Sleeper Cab		
	Low roof %	Mid roof %	High roof %	Low roof %	Mid roof %	High roof %	Low roof %	Mid roof %	High roof %
2021 MY Engine Technology Package									
	100	100	100	100	100	100	100	100	100
Aerodynamics									
Bin I	0	0	0	0	0	0	0	0	0
Bin II	75	75	0	75	75	0	75	75	0
Bin III	25	25	40	25	25	40	25	25	40
Bin IV	0	0	35	0	0	35	0	0	35
Bin V	N/A	N/A	20	N/A	N/A	20	N/A	N/A	20
Bin VI	N/A	N/A	5	N/A	N/A	5	N/A	N/A	5
Bin VII	N/A	N/A	0	N/A	N/A	0	N/A	N/A	0
Steer Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	60	60	60	60	60	60	60	60	60
Level 2	25	25	25	25	25	25	25	25	25
Level 3	10	10	10	10	10	10	10	10	10
Drive Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	60	60	60	60	60	60	60	60	60
Level 2	25	25	25	25	25	25	25	25	25
Level 3	10	10	10	10	10	10	10	10	10
Extended Idle Reduction									
APU	N/A	N/A	N/A	N/A	N/A	N/A	80	80	80
Transmission Type									
Manual	45	45	45	45	45	45	45	45	45
AMT	40	40	40	40	40	40	40	40	40
Auto	10	10	10	10	10	10	10	10	10
Dual Clutch	5	5	5	5	5	5	5	5	5
Driveline									
Axle Lubricant	20	20	20	20	20	20	20	20	20
6x2 or 4x2 Axle	....	....	....	10	10	20	10	10	20
Downspeed	20	20	20	20	20	20	20	20	20
Accessory Improvements									
A/C	10	10	10	10	10	10	10	10	10
Electric Access.	10	10	10	10	10	10	10	10	10
Other Technologies									
Predictive Cruise Control	20	20	20	20	20	20	20	20	20
Automated Tire Inflation System	20	20	20	20	20	20	20	20	20

TABLE III–9—TECHNOLOGY ADOPTION RATES FOR CLASS 7 AND 8 TRACTORS FOR DETERMINING THE PROPOSED 2024 MY STANDARDS

	Class 7			Class 8					
	Day cab			Day cab			Sleeper cab		
	Low roof %	Mid roof %	High roof %	Low roof %	Mid roof %	High roof %	Low roof %	Mid roof %	High roof %
2024 MY Engine Technology Package									
	100	100	100	100	100	100	100	100	100
Aerodynamics									
Bin I	0	0	0	0	0	0	0	0	0
Bin II	60	60	0	60	60	0	60	60	0
Bin III	38	38	30	38	38	30	38	38	30
Bin IV	2	2	30	2	2	30	2	2	30
Bin V	N/A	N/A	25	N/A	N/A	25	N/A	N/A	25
Bin VI	N/A	N/A	13	N/A	N/A	13	N/A	N/A	13
Bin VII	N/A	N/A	2	N/A	N/A	2	N/A	N/A	2
Steer Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	50	50	50	50	50	50	50	50	50
Level 2	30	30	30	30	30	30	30	30	30
Level 3	15	15	15	15	15	15	15	15	15
Drive Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	50	50	50	50	50	50	50	50	50
Level 2	30	30	30	30	30	30	30	30	30
Level 3	15	15	15	15	15	15	15	15	15
Extended Idle Reduction									
APU	N/A	N/A	N/A	N/A	N/A	N/A	90	90	90
Transmission Type									
Manual	20	20	20	20	20	20	20	20	20
AMT	50	50	50	50	50	50	50	50	50
Auto	20	20	20	20	20	20	20	20	20
Dual Clutch	10	10	10	10	10	10	10	10	10
Driveline									
Axle Lubricant	40	40	40	40	40	40	40	40	40
6x2 or 4x2 Axle	....	....	....	20	20	60	20	20	60
Downspeed	40	40	40	40	40	40	40	40	40
Direct Drive	50	50	50	50	50	50	50	50	50
Accessory Improvements									
A/C	20	20	20	20	20	20	20	20	20
Electric Access.	20	20	20	20	20	20	20	20	20
Other Technologies									
Predictive Cruise Control	40	40	40	40	40	40	40	40	40
Automated Tire Inflation System	40	40	40	40	40	40	40	40	40

TABLE III–10—TECHNOLOGY ADOPTION RATES FOR CLASS 7 AND 8 TRACTORS FOR DETERMINING THE PROPOSED 2027 MY STANDARDS

	Class 7			Class 8					
	Day cab			Day cab			Sleeper cab		
	Low roof %	Mid roof %	High roof %	Low roof %	Mid roof %	High roof %	Low roof %	Mid roof %	High roof %
2027 MY Engine Technology Package									
	100	100	100	100	100	100	100	100	100
Aerodynamics									
Bin I	0	0	0	0	0	0	0	0	0
Bin II	50	50	0	50	50	0	50	50	0
Bin III	40	40	20	40	40	20	40	40	20
Bin IV	10	10	20	10	10	20	10	10	20
Bin V	N/A	N/A	35	N/A	N/A	35	N/A	N/A	35
Bin VI	N/A	N/A	20	N/A	N/A	20	N/A	N/A	20
Bin VII	N/A	N/A	5	N/A	N/A	5	N/A	N/A	5
Steer Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	20	20	20	20	20	20	20	20	20
Level 2	50	50	50	50	50	50	50	50	50
Level 3	25	25	25	25	25	25	25	25	25
Drive Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	20	20	20	20	20	20	20	20	20
Level 2	50	50	50	50	50	50	50	50	50
Level 3	25	25	25	25	25	25	25	25	25
Extended Idle Reduction									
APU	N/A	N/A	N/A	N/A	N/A	N/A	90	90	90
Transmission Type									
Manual	10	10	10	10	10	10	10	10	10
AMT	50	50	50	50	50	50	50	50	50
Auto	30	30	30	30	30	30	30	30	30
Dual Clutch	10	10	10	10	10	10	10	10	10
Driveline									
Axle Lubricant	40	40	40	40	40	40	40	40	40
6x2 Axle	....	....	....	20	20	60	20	20	60
Downspeed	60	60	60	60	60	60	60	60	60
Direct Drive	50	50	50	50	50	50	50	50	50
Accessory Improvements									
A/C	30	30	30	30	30	30	30	30	30
Electric Access.	30	30	30	30	30	30	30	30	30
Other Technologies									
Predictive Cruise Control	40	40	40	40	40	40	40	40	40
Automated Tire Inflation System	40	40	40	40	40	40	40	40	40

(d) Derivation of the Proposed Tractor Standards

The agencies used the technology effectiveness inputs and technology adoption rates to develop GEM inputs to derive the proposed HD Phase 2 fuel consumption and CO_2 emissions standards for each subcategory of Class 7 and 8 combination tractors. Note that we have analyzed *one* technology pathway for each proposed level of stringency, but manufacturers would be free to use any combination of technology to meet the standards, and with the flexibility of averaging, banking and trading, to meet the standard on average. The agencies derived a scenario tractor for each subcategory by weighting the individual GEM input parameters included in Table III–7 with the adoption rates in Table III–8 through Table III–10. For example, the proposed CdA value for a 2021MY Class 8 Sleeper Cab High Roof scenario case was derived as 40 percent times 6.3 plus 35 percent times 5.6 plus 20 percent times 5.1 plus 5 percent times 4.7, which is equal to a CdA of 5.74 m². Similar calculations were made for tire rolling resistance, transmission types, idle reduction, and other technologies. To account for the proposed engine standards and engine technologies, the agencies assumed a compliant engine fuel map in GEM.[166] The agencies then ran GEM with a single set of vehicle inputs, as shown in Table III–11, to derive the proposed standards for each subcategory. Additional detail is provided in the draft RIA Chapter 2.

TABLE III–11—GEM INPUTS FOR THE PROPOSED 2021MY CLASS 7 AND 8 TRACTOR STANDARD SETTING

Class 7			Class 8					
Day cab			Day cab			Sleeper cab		
Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
Engine								
2021MY 11L Engine 350 HP	2021MY 11L Engine 350 HP	2021MY 11L Engine 350 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP	2021MY 15L Engine 455 HP
Aerodynamics (CdA in m²)								
4.68	6.08	5.94	4.68	6.08	5.94	4.68	6.08	5.74
Steer Tires (CRR in kg/metric ton)								
6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
Drive Tires (CRR in kg/metric ton)								
6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Extended Idle Reduction Weighted Effectiveness								
N/A	N/A	N/A	N/A	N/A	N/A	2.5%	2.5%	2.5%
Transmission = 10 speed Automated Manual Transmission								
Gear Ratios = 12.8, 9.25, 6.76, 4.90, 3.58, 2.61, 1.89, 1.38, 1.00, 0.73								
Drive axle Ratio = 3.55								
6x2 Axle Weighted Effectiveness								
N/A	N/A	N/A	0.3%	0.3%	0.5%	0.3%	0.3%	0.5%
Low Friction Axle Lubrication = 0.1%								
Transmission benefit = 1.1%								
Predictive Cruise Control = 0.4%								
Accessory Improvements = 0.1%								
Air Conditioner Efficiency Improvements = 0.1%								
Automatic Tire Inflation Systems = 0.2%								
Weight Reduction = 0 lbs								

[166] *See* Section II.D above explaining the derivation of the proposed engine standards.

TABLE III–12—GEM INPUTS FOR THE PROPOSED 2024MY CLASS 7 AND 8 TRACTOR STANDARD SETTING

Class 7			Class 8					
Day cab			Day cab			Sleeper cab		
Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
Engine								
2024MY 11L Engine 350 HP	2024MY 11L Engine 350 HP	2024MY 11L Engine 350 HP	2024MY 15L Engine 455 HP	2024MY 15L Engine 455 HP	2024MY 15L Engine 455 HP	2024MY 15L Engine 455 HP	2024MY 15L Engine 455 HP	2024MY 15L Engine 455 HP
Aerodynamics (CdA in m²)								
4.59	5.99	5.74	4.59	5.99	5.74	4.59	5.99	5.54
Steer Tires (CRR in kg/metric ton)								
5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Drive Tires (CRR in kg/metric ton)								
6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
Extended Idle Reduction Weighted Effectiveness								
N/A	N/A	N/A	N/A	N/A	N/A	3%	3%	3%
Transmission = 10 speed Automated Manual Transmission								
Gear Ratios = 12.8, 9.25, 6.76, 4.90, 3.58, 2.61, 1.89, 1.38, 1.00, 0.73								
Drive axle Ratio = 3.36								
6x2 Axle Weighted Effectiveness								
N/A	N/A	N/A	0.5%	0.5%	1.5%	0.5%	0.5%	1.5%
Low Friction Axle Lubrication = 0.2%								
Transmission benefit = 1.6%								
Predictive Cruise Control = 0.8%								
Accessory Improvements = 0.2%								
Air Conditioner Efficiency Improvements = 0.1%								
Automatic Tire Inflation Systems = 0.4%								
Weight Reduction = 0 lbs								
Direct Drive Weighted Efficiency = 1% for sleeper cabs; 0.8% for day cabs								

TABLE III–13—GEM INPUTS FOR THE PROPOSED 2027MY CLASS 7 AND 8 TRACTOR STANDARD SETTING

Class 7			Class 8					
Day cab			Day cab			Sleeper cab		
Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
Engine								
2027MY 11L Engine 350 HP	2027MY 11L Engine 350 HP	2027MY 11L Engine 350 HP	2027MY 15L Engine 455 HP	2027MY 15L Engine 455 HP	2027MY 15L Engine 455 HP	2027MY 15L Engine 455 HP	2027MY 15L Engine 455 HP	2027MY 15L Engine 455 HP
Aerodynamics (CdA in m²)								
4.52	5.92	5.52	4.52	5.92	5.52	4.52	5.92	5.32
Steer Tires (CRR in kg/metric ton)								
5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6

TABLE III–13—GEM INPUTS FOR THE PROPOSED 2027MY CLASS 7 AND 8 TRACTOR STANDARD SETTING—Continued

Class 7			Class 8					
Day cab			Day cab			Sleeper cab		
Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
Drive Tires (CRR in kg/metric ton)								
5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Extended Idle Reduction Weighted Effectiveness								
N/A	N/A	N/A	N/A	N/A	N/A	3%	3%	3%
Transmission = 10 speed Automated Manual Transmission								
Gear Ratios = 12.8, 9.25, 6.76, 4.90, 3.58, 2.61, 1.89, 1.38, 1.00, 0.73								
Drive axle Ratio = 3.2								
6x2 Axle Weighted Effectiveness								
N/A	N/A	N/A	0.5%	0.5%	1.5%	0.5%	0.5%	1.5%
Low Friction Axle Lubrication = 0.2%								
Transmission benefit = 1.8%								
Predictive Cruise Control = 0.8%								
Accessory Improvements = 0.3%								
Air Conditioner Efficiency Improvements = 0.2%								
Automatic Tire Inflation Systems = 0.4%								
Weight Reduction = 0 lbs								
Direct Drive Weighted Efficiency = 1% for sleeper cabs; 0.8% for day cabs								

The proposed level of the 2027 model year standards, in addition to the phase-in standards in model years 2021 and 2024 for each subcategory is included in Table III–14.

TABLE III–14—PROPOSED 2021, 2024, AND 2027 MODEL YEAR TRACTOR STANDARDS

	Day cab		Sleeper Cab
	Class 7	Class 8	Class 8
2021 Model Year CO_2 Grams per Ton-Mile			
Low Roof	97	78	70
Mid Roof	107	84	78
High Roof	109	86	77
2021 Model Year Gallons of Fuel per 1,000 Ton-Mile			
Low Roof	9.5285	7.6621	6.8762
Mid Roof	10.5108	8.2515	7.6621
High Roof	10.7073	8.4479	7.5639
2024 Model Year CO_2 Grams per Ton-Mile			
Low Roof	90	72	64
Mid Roof	100	78	71
High Roof	101	79	70
2024 Model Year and Later Gallons of Fuel per 1,000 Ton-Mile			
Low Roof	8.8409	7.0727	6.2868
Mid Roof	9.8232	7.6621	6.9745
High Roof	9.9214	7.7603	6.8762

TABLE III–14—PROPOSED 2021, 2024, AND 2027 MODEL YEAR TRACTOR STANDARDS—Continued

	Day cab		Sleeper Cab
	Class 7	Class 8	Class 8
2027 Model Year CO_2 Grams per Ton-Mile			
Low Roof	87	70	62
Mid Roof	96	76	69
High Roof	96	76	67
2027 Model Year and Later Gallons of Fuel per 1,000 Ton-Mile			
Low Roof	8.5462	6.8762	6.0904
Mid Roof	9.4303	7.4656	6.7780
High Roof	9.4303	7.4656	6.5815

A summary of the draft technology package costs is included in Table III–15 through Table III–17 for MYs 2021, 2024, and 2027, respectively, with additional details available in the draft RIA Chapter 2.12. We welcome comments on the technology costs.

TABLE III–15—CLASS 7 AND 8 TRACTOR TECHNOLOGY INCREMENTAL COSTS IN THE 2021 MODEL YEAR [a] [b] PREFERRED ALTERNATIVE VS. THE LESS DYNAMIC BASELINE

[2012$ per vehicle]

	Class 7		Class 8				
	Day cab		Day cab		Sleeper cab		
	Low/mid roof	High roof	Low/mid roof	High roof	Low roof	Mid roof	High roof
Engine [c]	$314	$314	$314	$314	$314	$314	$314
Aerodynamics	687	511	687	511	656	656	535
Tires	49	9	81	15	59	59	15
Tire inflation system	180	180	180	180	180	180	180
Transmission	3,969	3,969	3,969	3,969	3,969	3,969	3,969
Axle & axle lubes	50	50	70	90	70	70	90
Idle reduction with APU	0	0	0	0	2,449	2,449	2,449
Air conditioning	45	45	45	45	45	45	45
Other vehicle technologies	174	174	174	174	174	174	174
Total	5,468	5,252	5,520	5,298	7,916	7,916	7,771

Notes:

[a] Costs shown are for the 2021 model year and are incremental to the costs of a tractor meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated tractor classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see draft RIA 2.12 in particular).

[c] Engine costs are for a heavy HD diesel engine meant for a combination tractor. The engine costs in this table are equal to the engine costs associated with the separate engine standard because both include the same set of engine technologies (see Section II.D.2.d.i).

TABLE III–16—CLASS 7 AND 8 TRACTOR TECHNOLOGY INCREMENTAL COSTS IN THE 2024 MODEL YEAR [a] [b] PREFERRED ALTERNATIVE VS. THE LESS DYNAMIC BASELINE

[2012$ per vehicle]

	Class 7		Class 8				
	Day cab		Day cab		Sleeper cab		
	Low/mid roof	High roof	Low/mid roof	High roof	Low roof	Mid roof	High roof
Engine [c]	$904	$904	$904	$904	$904	$904	$904
Aerodynamics	744	684	744	684	712	712	723
Tires	47	11	78	18	58	58	18
Tire inflation system	330	330	330	330	330	330	330
Transmission	5,883	5,883	5,883	5,883	5,883	5,883	5,883
Axle & axle lubes	92	92	128	200	128	128	200
Idle reduction with APU	0	0	0	0	2,687	2,687	2,687
Air conditioning	82	82	82	82	82	82	82

TABLE III–16—CLASS 7 AND 8 TRACTOR TECHNOLOGY INCREMENTAL COSTS IN THE 2024 MODEL YEAR [a] [b] PREFERRED ALTERNATIVE VS. THE LESS DYNAMIC BASELINE—Continued

[2012$ per vehicle]

	Class 7		Class 8				
	Day cab		Day cab		Sleeper cab		
	Low/mid roof	High roof	Low/mid roof	High roof	Low roof	Mid roof	High roof
Other vehicle technologies	318	318	318	318	318	318	318
Total	8,400	8,304	8,467	8,419	11,102	11,102	11,145

Notes:

[a] Costs shown are for the 2024 model year and are incremental to the costs of a tractor meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated tractor classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[c] Engine costs are for a heavy HD diesel engine meant for a combination tractor. The engine costs in this table are equal to the engine costs associated with the separate engine standard because both include the same set of engine technologies (see Section II.D.2.d.i).

TABLE III–17—CLASS 7 AND 8 TRACTOR TECHNOLOGY INCREMENTAL COSTS IN THE 2027 MODEL YEAR [a] [b] PREFERRED ALTERNATIVE VS. THE LESS DYNAMIC BASELINE

[2012$ per vehicle]

	Class 7		Class 8				
	Day cab		Day cab		Sleeper cab		
	Low/mid roof	High roof	Low/mid roof	High roof	Low roof	Mid roof	High roof
Engine [c]	$1,698	$1,698	$1,698	$1,698	$1,698	$1,698	$1,698
Aerodynamics	771	765	771	765	733	733	802
Tires	45	10	75	17	56	56	17
Tire inflation system	314	314	314	314	314	314	314
Transmission	6,797	6,797	6,797	6,797	6,797	6,797	6,797
Axle & axle lubes	97	97	131	200	131	131	200
Idle reduction with APU	0	0	0	0	2,596	2,596	2,596
Air conditioning	117	117	117	117	117	117	117
Other vehicle technologies	302	302	302	302	302	302	302
Total	10,140	10,099	10,204	10,209	12,744	12,744	12,842

Notes:

[a] Costs shown are for the 2027 model year and are incremental to the costs of a tractor meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated tractor classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see draft RIA 2.12 in particular).

[c] Engine costs are for a heavy HD diesel engine meant for a combination tractor. The engine costs in this table are equal to the engine costs associated with the separate engine standard because both include the same set of engine technologies (see Section II.D.2.d.i).

(i) Proposed Heavy-Haul Tractor Standards

For Phase 2, the agencies propose to add a tenth subcategory to the tractor category for heavy-haul tractors. The agencies recognize the need for manufacturers to build these types of vehicles for specific applications and believe the appropriate way to prevent penalizing these vehicles is to set separate standards recognizing a heavy-haul vehicle's unique needs, such as requiring a higher horsepower engine or different transmissions. The agencies are proposing this change in Phase 2 because unlike in Phase 1 the engine, transmission, and drivetrain technologies are included in the technology packages used to determine the stringency of the proposed tractor standards and are included as manufacturer inputs in GEM. This means that the agencies can adopt a standard reflecting individualized performance of these technologies in particular applications, in this case, heavy-haul tractors, and further, have a means of reliably assessing individualized performance of these technology at certification.

The typical tractor is designed with a Gross Combined Weight Rating (GCWR) of approximately 80,000 lbs due to the effective weight limit on the federal highway system, except in states with preexisting higher weight limits. The agencies propose to consider tractors with a GCWR over 120,000 lbs as heavy-haul tractors. Based on comments received during the development of HD Phase 1 (76 FR 57136–57138) and because we are not proposing a sales limit for heavy-haul like we have for the vocational tractors, the agencies also believe it would be appropriate to further define the heavy-haul vehicle characteristics to differentiate these vehicles from the vehicles in the other nine tractor subcategories. The two additional requirements would include a total gear reduction greater than or equal to 57:1 and a frame Resisting Bending Moment (RBM) greater than or equal to 2,000,000 in-lbs per rail or rail and liner combination. Heavy-haul tractors typically require the large gear reduction to provide the torque necessary to start the vehicle moving. These vehicles also typically require frame rails with extra strength to ensure the ability to haul heavy loads. We welcome comment on the proposed heavy-haul tractor specifications, including whether Gross Vehicle Weight Rating (GVWR) or Gross Axle Weight Rating (GAWR) would be a more appropriate metric to differentiate between a heavy-haul tractor and a typical tractor.

The agencies propose that heavy-haul tractors demonstrate compliance with the proposed standards using the day cab drive cycle weightings of 19 percent transient cycle, 17 percent 55 mph cycle, and 64 percent 65 mph cycle. We also propose that GEM simulates the heavy-haul tractors with a payload of 43 tons and a total tractor, trailer, and payload weight of 118,500 lbs. In addition, we propose that the engines installed in heavy-haul tractors meet the proposed tractor engine standards included in 40 CFR 1036.108. We welcome comments on these proposed specifications.

The agencies recognize that certain technologies used to determine the stringency of the proposed Phase 2 tractor standards are less applicable to heavy-haul tractors. Heavy-haul tractors are not typically used in the same manner as long-haul tractors with extended highway driving, and therefore would experience less benefit from aerodynamics. Aerodynamic technologies are very effective at reducing the fuel consumption and GHG emissions of tractors, but only when traveling at highway speeds. At lower speeds, the aerodynamic technologies may have a detrimental impact due to the potential of added weight. The agencies therefore are not considering the use of aerodynamic technologies in the development of the proposed Phase 2 heavy-haul tractor standards. Moreover, because aerodynamics would not play a role in the heavy-haul standards, the agencies propose to combine all of the heavy-haul tractor cab configurations (day and sleeper) and roof heights (low, mid, and high) into a single heavy-haul tractor subcategory.[167] We welcome comment on this approach.

Certain powertrain and drivetrain components are also impacted during the design of a heavy-haul tractor, including the transmission, axles, and the engine. Heavy-haul tractors typically require transmissions with 13 or 18 speeds to provide the ratio spread to ensure that the tractor is able to start pulling the load from a stop. Downsped powertrains are typically not an option for heavy-haul operations because these vehicles require more torque to move the vehicle because of the heavier load. Finally, due to the loading requirements of the vehicle, it is not likely that a 6x2 axle configuration can be used in heavy-haul applications.

The agencies used the following heavy-haul tractor inputs for developing the proposed 2021, 2024, and 2027 MY standards, as shown in Table III–18 and Table III–19.

TABLE III–18—APPLICATION RATES FOR PROPOSED HEAVY-HAUL TRACTOR STANDARDS

Heavy-Haul Tractor Application Rates			
	2021MY	2024MY	2027MY
Engine	2021 MY 15L Engine with 600 HP (%)	2024 MY 15L Engine with 600 HP (%)	2027 MY 15L Engine with 600 HP (%)
Aerodynamics—0%			
Steer Tires			
Phase 1 Baseline	5	5	5
Level I	60	50	20
Level 2	25	30	50
Level 3	10	15	25
Drive Tires			
Phase 1 Baseline	5	5	5
Level I	60	50	20
Level 2	25	30	50
Level 3	10	15	25
Transmission			
AMT	40	50	50
Automatic	10	20	30
DCT	5	10	10
Other Technologies			
6x2 Axle	0	0	0
Low Friction Axle Lubrication	20	40	40
Predictive Cruise Control	20	40	40
Accessory Improvements	10	20	30
Air Conditioner Efficiency Improvements	10	20	30
Automatic Tire Inflation Systems	20	40	40

[167] Since aerodynamic improvements are not part of the technology package, the agencies likewise are not proposing any bin structure for the heavy-haul tractor subcategory.

TABLE III–18—APPLICATION RATES FOR PROPOSED HEAVY-HAUL TRACTOR STANDARDS—Continued

Heavy-Haul Tractor Application Rates			
Engine	2021MY 2021 MY 15L Engine with 600 HP (%)	2024MY 2024 MY 15L Engine with 600 HP (%)	2027MY 2027 MY 15L Engine with 600 HP (%)
Weight Reduction	0	0	0

TABLE III–19—GEM INPUTS FOR PROPOSED 2021, 2024 AND 2027 MY HEAVY-HAUL TRACTOR STANDARDS

Heavy-haul tractor			
Baseline	2021MY	2024MY	2027MY
Engine = 2017 MY 15L Engine with 600 HP.	Engine = 2021 MY 15L Engine with 600 HP.	Engine = 2024 MY 15L Engine with 600 HP.	Engine = 2027 MY 15L Engine with 600 HP
Aerodynamics (CdA in m²) = 5.00			
Steer Tires (CRR in kg/metric ton) = 7.0.	Steer Tires (CRR in kg/metric ton) = 6.2.	Steer Tires (CRR in kg/metric ton) = 6.0.	Steer Tires (CRR in kg/metric ton) = 5.8.
Drive Tires (CRR in kg/metric ton) = 7.4.	Drive Tires (CRR in kg/metric ton) = 6.6.	Drive Tires (CRR in kg/metric ton) = 6.4.	Drive Tires (CRR in kg/metric ton) = 6.2.
Transmission = 13 speed Manual Transmission, Gear Ratios = 12.29, 8.51, 6.05, 4.38, 3.20, 2.29, 1.95, 1.62, 1.38, 1.17, 1.00, 0.86, 0.73.	Transmission = 13 speed Automated Manual Transmission, Gear Ratios = 12.29, 8.51, 6.05, 4.38, 3.20, 2.29, 1.95, 1.62, 1.38, 1.17, 1.00, 0.86, 0.73.	Transmission = 13 speed Automated Manual Transmission, Gear Ratios = 12.29, 8.51, 6.05, 4.38, 3.20, 2.29, 1.95, 1.62, 1.38, 1.17, 1.00, 0.86, 0.73.	Transmission = 13 speed Automated Manual Transmission, Gear Ratios = 12.29, 8.51, 6.05, 4.38, 3.20, 2.29, 1.95, 1.62, 1.38, 1.17, 1.00, 0.86, 0.73.
Drive axle Ratio = 3.55	Drive axle Ratio = 3.55	Drive axle Ratio = 3.55	Drive axle Ratio = 3.55.
N/A	6x2 Axle Weighted Effectiveness = 0%.	6x2 Axle Weighted Effectiveness = 0%.	6x2 Axle Weighted Effectiveness = 0%.
N/A	Low Friction Axle Lubrication = 0.1%.	Low Friction Axle Lubrication = 0.2%.	Low Friction Axle Lubrication = 0.2%.
N/A	AMT benefit = 1.1%	AMT benefit = 1.8%	AMT benefit = 1.8%.
N/A	Predictive Cruise Control = 0.4%	Predictive Cruise Control = 0.8%	Predictive Cruise Control = 0.8%.
N/A	Accessory Improvements = 0.1%	Accessory Improvements = 0.2%	Accessory Improvements = 0.3%.
N/A	Air Conditioner Efficiency Improvements = 0.1%.	Air Conditioner Efficiency Improvements = 0.1%.	Air Conditioner Efficiency Improvements = 0.2%.
N/A	Automatic Tire Inflation Systems = 0.2%.	Automatic Tire Inflation Systems = 0.4%.	Automatic Tire Inflation Systems = 0.4%.
N/A	Weight Reduction = 0 lbs	Weight Reduction = 0 lbs	Weight Reduction = 0 lbs.

The baseline 2017 MY heavy-haul tractor would emit 57 grams of CO_2 per ton-mile and consume 5.6 gallons of fuel per 1,000 ton-mile. The agencies propose the heavy-haul standards shown in Table III–20. We welcome comment on the heavy-haul tractor technology path and standards proposed by the agencies.

TABLE III–20—PROPOSED HEAVY-HAUL TRACTOR STANDARDS

	Heavy-haul tractor		
	2021 MY	2024 MY	2027 MY
Grams of CO_2 per Ton-Mile Standard	54	52	51
Gallons of Fuel per 1,000 Ton-Mile	5.3045	5.1081	5.010

The technology costs associated with the proposed heavy-haul tractor standards are shown below in Table III–21. We welcome comment on the technology costs.

TABLE III–21—HEAVY-HAUL TRACTOR TECHNOLOGY INCREMENTAL COSTS IN THE 2021, 2024, AND 2027 MODEL YEAR [a b] PREFERRED ALTERNATIVE VS. THE LESS DYNAMIC BASELINE

[2012$ per vehicle]

	2021 MY	2024 MY	2027 MY
Engine [c]	$314	$904	$1,698
Tires	81	78	75
Tire inflation system	180	330	314
Transmission	3,969	5,883	6,797
Axle & axle lubes	70	128	200
Air conditioning	45	82	117
Other vehicle technologies	174	318	302
Total	4,833	7,723	9,503

Notes:

[a] Costs shown are for the specified model year and are incremental to the costs of a tractor meeting the phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated tractor classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see draft RIA 2.12 in particular).

[c] Engine costs are for a heavy HD diesel engine meant for a combination tractor.

(e) Consistency of the Proposed Tractor Standards With the Agencies' Legal Authority

The proposed HD Phase 2 standards are based on adoption rates for technologies that the agencies regard, subject to consideration of public comment, as the maximum feasible for purposes of EISA Section 32902 (k) and appropriate under CAA Section 202 (a) for the reasons given in Section III.D.2(b) through (d) above; see also draft RIA Chapter 2.4. The agencies believe these technologies can be adopted at the estimated rates for these standards within the lead time provided, as discussed in draft RIA Chapter 2. The 2021 and 2024 MY standards are phase-in standards on the path to the 2027 MY standards and were developed using less aggressive application rates and therefore have lower technology package costs than the 2027 MY standards. Moreover, we project the cost of these technologies would be rapidly recovered by operators due to the associated fuel savings, as shown in the payback analysis included in Section IX below. The cost per tractor to meet the proposed 2027 MY standards is projected to range between $10,000 and $13,000 (much or all of this would be mitigated by the fuel savings during the first two years of ownership). The agencies note that while the projected costs are significantly greater than the costs projected for Phase 1, we still consider that cost to be reasonable, especially given the relatively short payback period. In this regard the agencies note that the estimated payback period for tractors of less than two years [168] is itself shorter than the estimated payback period for light duty trucks in the 2017–2025 light duty greenhouse gas standards. That period was slightly over three years, see 77 FR 62926–62927, which EPA found to be a highly reasonable given the usual period of ownership of light trucks is typically five years.[169] The same is true here. Ownership of new tractors is customarily four to six years, meaning that the greenhouse gas and fuel consumption technologies pay for themselves early on and the purchaser sees overall savings in succeeding years—while still owning the vehicle.[170] The agencies note further that the costs for each subcategory are relatively proportionate; that is, costs of any single tractor subcategory are not disproportionately higher (or lower) than any other. Although the proposal is technology-forcing (especially with respect to aerodynamic and tire rolling resistance improvements), the agencies believe that manufacturers retain leeway to develop alternative compliance paths, increasing the likelihood of the standards' successful implementation. The agencies also regard these reductions as cost-effective, even without considering payback period. The agencies estimate the cost per metric ton of CO_2eq reduction without considering fuel savings to be $20 in 2030, and we estimate the cost per gallon of avoided fuel consumption to be about $0.25 per gallon, which compares favorably with the levels of cost effectiveness the agencies found to be reasonable for light duty trucks.[171 172] See 77 FR 62922. The proposed phase-in 2021 and 2024 MY standards are less stringent and less costly than the proposed 2027 MY standards. For these reasons, and because the agencies have carefully considered lead time, EPA believes they are also reasonable under Section 202(a) of the CAA. Given that the agencies believe the proposed standards are technically feasible, are highly cost effective, and highly cost effective when accounting for the fuel savings, and have no apparent adverse potential impacts (*e.g.,* there are no projected negative impacts on safety or vehicle utility), the proposed standards appear to represent a reasonable choice under Section 202(a) of the CAA and the maximum feasible under NHTSA's EISA authority at 49 U.S.C. 32902(k)(2).

Based on the information before the agencies, we currently believe that Alternative 3 would be maximum feasible and reasonable for the tractor segment for the model years in question. The agencies believe Alternative 4 has potential to be the maximum feasible and reasonable alternative; however, based on the evidence currently before us, EPA and NHTSA have outstanding questions regarding relative risks and benefits of Alternative 4 due to the timeframe envisioned by the alternative. Alternative 3 is generally designed to achieve the levels of fuel consumption and GHG reduction that Alternative 4 would achieve, but with several years of

[168] See Draft RIA Chapter 7.1.3.

[169] Auto Remarketing. Length of Ownership Returning to More Normal Levels; New Registrations Continue Slow Climb. April 1, 2013. Last accessed on February 26, 2015 at *http://www.autoremarketing.com/trends/length-ownership-returning-more-normal-levels-new-registrations-continue-slow-climb.*

[170] North American Council for Freight Efficiency. Barriers to Increased Adoption of Fuel Efficiency Technologies in Freight Trucking. July 2013. Page 24.

[171] See Draft RIA Chapter 7.1.4.

[172] If using a cost effectiveness metric that treats fuel savings as a negative cost, net costs per ton of GHG emissions reduced or per gallon of avoided fuel consumption would be negative under the proposed standards.

additional lead-time—*i.e.,* the Alternative 3 standards would end up in the same place as the Alternative 4 standards, but several years later, meaning that manufacturers could, in theory, apply new technology at a more gradual pace and with greater flexibility. However, Alternative 4 would provide earlier GHG benefits compared to Alternative 3.

(f) Alternative Tractor Standards Considered

The agencies developed and considered other alternative levels of stringency for the Phase 2 program. The results of the analysis of these alternatives are discussed below in Section X of the preamble. For tractors, the agencies developed the following alternatives as shown in Table III–22.

TABLE III–22—SUMMARY OF ALTERNATIVES CONSIDERED FOR THE PROPOSED RULEMAKING

Alternative 1	No action alternative
Alternative 2	Less Stringent than the Proposed Alternative applying off-the-shelf technologies.
Alternative 3 (Proposed Alternative)	Proposed Alternative fully phased-in by 2027 MY.
Alternative 4	Alternative that pulls ahead the proposed 2027 MY standards to 2024 MY.
Alternative 5	Alternative based on very high market adoption of advanced technologies.

When evaluating the alternatives, it is necessary to evaluate the impact of a proposed regulation in terms of CO_2 emission reductions, fuel consumption reductions, and technology costs. However, it is also necessary to consider other aspects, such as manufacturers' research and development resources, the impact on purchase price, and the impact on purchasers. Manufacturers are limited in their ability to develop and implement new technologies due to their human resources and budget constraints. This has a direct impact on the amount of lead time that is required to meet any new standards. From the owner/operator perspective, heavy-duty vehicles are a capital investment for firms and individuals so large increases in the upfront cost could impact buying patterns. Though the dollar value of the lifetime fuel savings will far exceed the upfront technology costs, purchasers often discount future fuel savings for a number of reasons. The purchaser often has uncertainty in the amount of fuel savings that can be expected for their specific operation due to the diversity of the heavy-duty tractor market. Although a nationwide perspective that averages out this uncertainty is appropriate for rulemaking analysis, individual operators must consider their potentially narrow operation. In addition, purchasers often put a premium on reliability (because downtime is costly in terms of towing, repair, late deliveries, and lost revenue) and may perceive any new technology as a potential risk with respect to reliability. Another factor that purchasers consider is the impact of a new technology on the resale market, which can also be impacted by uncertainty.

The agencies selected the proposed standards over the more stringent alternatives based on considering the relevant statutory factors. In 2027, the proposed standards achieve up to a 24 percent reduction in CO_2 emissions and fuel consumption compared to a Phase 1 tractor at a per vehicle cost of approximately $13,000. Alternative 4 achieves the same percent reduction in CO_2 emissions and fuel consumption compared to a Phase 1 tractor, but three years earlier, at a per vehicle cost of approximately $14,000. The alternative standards are projected to result in more emission and fuel consumption reductions from the heavy-duty tractors built in model years 2021 through 2026.[173] We project the proposed standards to be achievable within known design cycles, and we believe these standards would allow different paths to compliance in addition to the one we outline and cost here.

The agencies solicit comment on all of these issues and again note the possibility of adopting, in a final action, standards that are more accelerated than those proposed in Alternative 3. The agencies are also assuming that both the proposed standards and Alternative 4 could be accomplished with all changes being made during manufacturers' normal product design cycles. However, we note that doing so would be more challenging for Alternative 4 and may require accelerated research and development outside of design cycles with attendant increased costs.

The agencies are especially interested in seeking detailed comments on Alternative 4. Therefore, we are including the details of the Alternative 4 analysis below. The adoption rates considered for the 2021 and 2024 MY standards developed for Alternative 4 are shown below in Table III–23 and Table III–24. The inputs to GEM used to develop the Alternative 4 CO_2 and fuel consumption standards are shown below in Table III–25 and Table III–26. The standards associated with Alternative 4 are shown below in Table III–27. Commenters are encouraged to address all aspects of feasibility analysis, including costs, the likelihood of developing the technology to achieve sufficient relaibility within the proposed lead time, and the extent to which the market could utilize the technology.

(g) Derivation of Alternative 4 Tractor Standards

The adoption rates considered for the 2021 and 2024 MY standards developed for Alternative 4 are shown below in Table III–23 and Table III–24. The inputs to GEM used to develop the Alternative 4 CO_2 and fuel consumption standards are shown below in Table III–25 and Table III–26. The standards associated with Alternative 4 are shown below in Table III–27. Commenters are encouraged to address all aspects of feasibility analysis, including costs, the likelihood of developing the technology to achieve sufficient relaibility within the lead time.

[173] See Tables III–14 and III–27.

TABLE III–23—ALTERNATIVE 4 ADOPTION RATES FOR 2021 MY

	Class 7			Class 8					
	Day cab			Day cab			Sleeper cab		
	Low roof (%)	Mid roof (%)	High roof (%)	Low roof (%)	Mid roof (%)	High roof (%)	Low roof (%)	Mid roof (%)	High roof (%)
Alternative 4 2021MY Engine Technology Package									
....	100	100	100	100	100	100	100	100	100
Aerodynamics									
Bin I	0	0	0	0	0	0	0	0	0
Bin II	65	65	0	65	65	0	65	65	0
Bin III	30	30	35	30	30	35	30	30	35
Bin IV	5	5	30	5	5	30	5	5	30
Bin V	N/A	N/A	25	N/A	N/A	25	N/A	N/A	25
Bin VI	N/A	N/A	10	N/A	N/A	10	N/A	N/A	10
Bin VII	N/A	N/A	0	N/A	N/A	0	N/A	N/A	0
Steer Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	35	35	35	35	35	35	35	35	35
Level 2	45	45	45	45	45	45	45	45	45
Level 3	15	15	15	15	15	15	15	15	15
Drive Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	35	35	35	35	35	35	35	35	35
Level 2	45	45	45	45	45	45	45	45	45
Level 3	15	15	15	15	15	15	15	15	15
Extended Idle Reduction									
APU	N/A	N/A	N/A	N/A	N/A	N/A	80	80	80
Transmission Type									
Manual	25	25	25	25	25	25	25	25	25
AMT	40	40	40	40	40	40	40	40	40
Auto	30	30	30	30	30	30	30	30	30
Dual Clutch	5	5	5	5	5	5	5	5	5
Driveline									
Axle Lubricant	20	20	20	20	20	20	20	20	20
6×2 Axle	....	....	....	10	10	20	10	10	30
Downspeed	30	30	30	30	30	30	30	30	30
Direct Drive	50	50	50	50	50	50	50	50	50
Accessory Improvements									
A/C	20	20	20	20	20	20	20	20	20
Electric Access.	20	20	20	20	20	20	20	20	20
Other Technologies									
Predictive Cruise Control	30	30	30	30	30	30	30	30	30
Automated Tire Inflation System	30	30	30	30	30	30	30	30	30

TABLE III–24—ALTERNATIVE 4 ADOPTION RATES FOR 2024 MY

	Class 7			Class 8					
	Day cab			Day cab			Sleeper cab		
	Low roof (%)	Mid roof (%)	High roof (%)	Low roof (%)	Mid roof (%)	High roof (%)	Low roof (%)	Mid roof (%)	High roof (%)
Alternative 4 2024MY Engine Technology Package									
....	100	100	100	100	100	100	100	100	100
Aerodynamics									
Bin I	0	0	0	0	0	0	0	0	0
Bin II	50	50	0	50	50	0	50	50	0
Bin III	40	40	20	40	40	20	40	40	20
Bin IV	10	10	20	10	10	20	10	10	20
Bin V	N/A	N/A	35	N/A	N/A	35	N/A	N/A	35
Bin VI	N/A	N/A	20	N/A	N/A	20	N/A	N/A	20
Bin VII	N/A	N/A	5	N/A	N/A	5	N/A	N/A	5
Steer Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	20	20	20	20	20	20	20	20	20
Level 2	50	50	50	50	50	50	50	50	50
Level 3	25	25	25	25	25	25	25	25	25
Drive Tires									
Base	5	5	5	5	5	5	5	5	5
Level 1	20	20	20	20	20	20	20	20	20
Level 2	50	50	50	50	50	50	50	50	50
Level 3	25	25	25	25	25	25	25	25	25
Extended Idle Reduction									
APU	N/A	N/A	N/A	N/A	N/A	N/A	90	90	90
Transmission Type									
Manual	10	10	10	10	10	10	10	10	10
AMT	50	50	50	50	50	50	50	50	50
Auto	30	30	30	30	30	30	30	30	30
Dual Clutch	10	10	10	10	10	10	10	10	10
Driveline									
Axle Lubricant	40	40	40	40	40	40	40	40	40
6×2 Axle	....	....	....	20	20	60	20	20	60
Downsped	60	60	60	60	60	60	60	60	60
Direct Drive	50	50	50	50	50	50	50	50	50
Accessory Improvements									
A/C	30	30	30	30	30	30	30	30	30
Electric Access.	30	30	30	30	30	30	30	30	30
Other Technologies									
Predictive Cruise Control	40	40	40	40	40	40	40	40	40
Automated Tire Inflation System	40	40	40	40	40	40	40	40	40

TABLE III–25—ALTERNATIVE 4 GEM INPUTS FOR 2021MY

Class 7			Class 8					
Day cab			Day cab			Sleeper cab		
Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
Engine								
2021MY 11L Engine 350 HP—2% reduction	2021MY 11L Engine 350 HP—2% reduction	2021MY 11L Engine 350 HP—2% reduction	2021MY 15L Engine 455 HP—2% reduction	2021MY 15L Engine 455 HP—2% reduction	2021MY 15L Engine 455 HP—2% reduction	2021MY 15L Engine 455 HP—2% reduction	2021MY 15L Engine 455 HP—2% reduction	2021MY 15L Engine 455 HP—2% reduction
Aerodynamics (CdA in m²)								
4.61	6.01	5.83	4.61	6.01	5.83	4.61	6.01	5.63
Steer Tires (CRR in kg/metric ton)								
5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Drive Tires (CRR in kg/metric ton)								
6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
Extended Idle Reduction Weighted Effectiveness								
N/A	N/A	N/A	N/A	N/A	N/A	2.5%	2.5%	2.5%
Transmission = 10 speed Automated Manual Transmission **Gear Ratios =** 12.8, 9.25, 6.76, 4.90, 3.58, 2.61, 1.89, 1.38, 1.00, 0.73								
Drive axle Ratio = 3.45								
6x2 Axle Weighted Effectiveness								
N/A	N/A	N/A	0.3%	0.3%	0.8%	0.3%	0.3%	0.8%
Low Friction Axle Lubrication = 0.1%								
Transmission benefit = 1.5%								
Predictive Cruise Control = 0.6%								
Accessory Improvements = 0.2%								
Air Conditioner Efficiency Improvements = 0.1%								
Automatic Tire Inflation Systems = 0.3%								
Weight Reduction = 0 lbs								
Direct Drive Weighted Efficiency = 1% for sleeper cabs; 0.8% for day cabs								

TABLE III–26—ALTERNATIVE 4 GEM INPUTS FOR 2024MY

Class 7			Class 8					
Day cab			Day cab			Sleeper cab		
Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
Engine								
2021MY 11L Engine 350 HP—4% reduction	2021MY 11L Engine 350 HP—4% reduction	2021MY 11L Engine 350 HP—4% reduction	2021MY 15L Engine 455 HP—4% reduction	2021MY 15L Engine 455 HP—4% reduction	2021MY 15L Engine 455 HP—4% reduction	2021MY 15L Engine 455 HP—4% reduction	2021MY 15L Engine 455 HP—4% reduction	2021MY 15L Engine 455 HP—4% reduction
Aerodynamics (CdA in m²)								
4.52	5.92	5.52	4.52	5.92	5.52	4.52	5.92	5.32

TABLE III–26—ALTERNATIVE 4 GEM INPUTS FOR 2024MY—Continued

Class 7			Class 8					
Day cab			Day cab			Sleeper cab		
Low roof	Mid roof	High roof	Low roof	Mid roof	High roof	Low roof	Mid roof	High roof
Steer Tires (CRR in kg/metric ton)								
5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
Drive Tires (CRR in kg/metric ton)								
5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Extended Idle Reduction Weighted Effectiveness								
N/A	N/A	N/A	N/A	N/A	N/A	3%	3%	3%
Transmission = 10 speed Automated Manual Transmission **Gear Ratios =** 12.8, 9.25, 6.76, 4.90, 3.58, 2.61, 1.89, 1.38, 1.00, 0.73								
Drive axle Ratio = 3.2								
6x2 Axle Weighted Effectiveness								
N/A	N/A	N/A	0.5%	0.5%	1.5%	0.5%	0.5%	1.5%
Low Friction Axle Lubrication = 0.2%								
Transmission benefit = 1.8%								
Predictive Cruise Control = 0.8%								
Accessory Improvements = 0.3%								
Air Conditioner Efficiency Improvements = 0.2%								
Automatic Tire Inflation Systems = 0.4%								
Weight Reduction = 0 lbs								
Direct Drive Weighted Efficiency = 1% for sleeper cabs; 0.8% for day cabs								

TABLE III–27—TRACTOR STANDARDS ASSOCIATED WITH ALTERNATIVE 4

	Day cab		Sleeper cab
	Class 7	Class 8	Class 8
2021 Model Year CO_2 Grams per Ton-Mile			
Low Roof	92	74	66
Mid Roof	102	81	74
High Roof	104	82	73
2021 Model Year Gallons of Fuel per 1,000 Ton-Mile			
Low Roof	9.0373	7.2692	6.4833
Mid Roof	10.0196	7.9568	7.2692
High Roof	10.2161	8.0550	7.1709
2024 Model Year CO_2 Grams per Ton-Mile			
Low Roof	87	70	62
Mid Roof	96	76	69
High Roof	96	76	67
2024 Model Year and Later Gallons of Fuel per 1,000 Ton-Mile			
Low Roof	8.5462	6.8762	6.0904
Mid Roof	9.4303	7.4656	6.7780
High Roof	9.4303	7.4656	6.5815

The technology costs of achieving the reductions projected in Alternative 4 are included below in Table III–28 and Table III–29.

TABLE III–28—CLASS 7 AND 8 TRACTOR TECHNOLOGY INCREMENTAL COSTS IN THE 2021 MODEL YEAR ALTERNATIVE 4 VS. THE LESS DYNAMIC BASELINE [A B]

(2012$ per vehicle)

	Class 7		Class 8				
	Day cab		Day cab		Sleeper cab		
	Low/mid roof	High roof	Low/mid roof	High roof	Low roof	Mid roof	High roof
Engine [c]	$656	$656	$656	$656	$656	$656	$656
Aerodynamics	769	632	769	632	740	740	665
Tires	50	11	83	18	61	61	18
Tire inflation system	271	271	271	271	271	271	271
Transmission	6,794	6,794	6,794	6,794	6,794	6,794	6,794
Axle & axle lubes	56	56	75	95	75	75	115
Idle reduction with APU	0	0	0	0	2,449	2,449	2,449
Air conditioning	90	90	90	90	90	90	90
Other vehicle technologies	261	261	261	261	261	261	261
Total	8,946	8,769	8,999	8,816	11,397	11,397	11,318

Notes:

[a] Costs shown are for the 2021 model year and are incremental to the costs of a tractor meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated tractor classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see draft RIA 2.12 in particular).

[c] Engine costs are for a heavy HD diesel engine meant for a combination tractor. The engine costs in this table are equal to the engine costs associated with the separate engine standard because both include the same set of engine technologies (see Section II.D.2.e).

TABLE III–29—CLASS 7 AND 8 TRACTOR TECHNOLOGY INCREMENTAL COSTS IN THE 2024 MODEL YEAR ALTERNATIVE 4 VS. THE LESS DYNAMIC BASELINE [A B]

(2012$ per vehicle)

	Class 7		Class 8				
	Day cab		Day cab		Sleeper cab		
	Low/mid roof	High roof	Low/mid roof	High roof	Low roof	Mid roof	High roof
Engine [c]	$1,885	$1,885	$1,885	$1,885	$1,885	$1,885	$1,885
Aerodynamics	805	935	805	935	773	773	997
Tires	50	14	83	23	63	63	23
Tire inflation system	330	330	330	330	330	330	330
Transmission	7,143	7,143	7,143	7,143	7,143	7,143	7,143
Axle & axle lubes	102	102	138	210	138	138	210
Idle reduction with APU	0	0	0	0	2,687	2,687	2,687
Air conditioning	123	123	123	123	123	123	123
Other vehicle technologies	318	318	318	318	318	318	318
Total	10,757	10,851	10,826	10,968	13,461	13,461	13,717

Notes:

[a] Costs shown are for the 2024 model year and are incremental to the costs of a tractor meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated tractor classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see draft RIA 2.12 in particular).

[c] Engine costs are for a heavy HD diesel engine meant for a combination tractor. The engine costs in this table are equal to the engine costs associated with the separate engine standard because both include the same set of engine technologies (see Section II.D.2.e).

E. Proposed Compliance Provisions for Tractors

In HD Phase 1, the agencies developed an entirely new program to assess the CO_2 emissions and fuel consumption of tractors. The agencies propose to carry over many aspects of the Phase 1 compliance approach, but are proposing to enhance several aspects of the compliance program. The sections below highlight the key areas that are the same and those that are different.

(1) HD Phase 2 Compliance Provisions That Remain the Same

The regulatory structure considerations for Phase 2 are discussed in more detail above in Section II. We welcome comment on all aspects of the compliance program including where we are not proposing any changes.

(a) Application and Certification Process

For the Phase 2 proposed rule, the agencies are proposing to keep many aspects of the HD Phase 1 tractor compliance program. For example, the agencies propose to continue to use GEM (as revised for Phase 2), in coordination with additional component testing by manufacturers to determine the inputs, to determine compliance with the proposed fuel efficiency and CO_2 standards. Another aspect that we propose to carry over is the overall compliance approach.

In Phase 1 and as proposed in Phase 2, the general compliance process in terms of the pre-model year, during the model year, and post model year activities remain unchanged. The manufacturers would continue to be required to apply for certification through a single source, EPA, with limited sets of data and GEM results (see 40 CFR 1037.205). EPA would issue certificates upon approval based on information submitted through the VERIFY database (see 40 CFR 1037.255). In Phase 1, EPA and NHTSA jointly review and approve innovative technology requests, *i.e.* performance of any technology whose performance is not measured by the GEM simulation tool and is not in widespread use in the 2010 MY. For Phase 2, the agencies are proposing a similar process for allowing credits for off-cycle technologies that are not measured by the GEM simulation tool (see Section I.B.v. for a more detailed discussion of off-cycle requests). During the model year, the manufacturers would continue to generate certification data and conduct GEM runs on each of the vehicle configurations it builds. After the model year ends, the manufacturers would submit end of year reports to EPA that include the GEM results for all of the configurations it builds, along with credit/deficit balances if applicable (see 40 CFR 1037.250 and 1037.730). EPA and NHTSA would jointly coordinate on any enforcement action required.

(b) Compliance Requirements

The agencies are also proposing not to change the following provisions:

- Useful life of tractors (40 CFR 1037.105(e) and 1037.106(e)) although added for NHTSA in Phase 2 (40 CFR 535.5)
- Emission-related warranty requirements (40 CFR 1037.120)
- Maintenance instructions, allowable maintenance, and amending maintenance instructions (40 CFR 1037.125 and 137.220)
- Deterioration factors (40 CFR 1037.205(l) and 1037.241(c))
- Vehicle family, subfamily, and configurations (40 CFR 1037.230)

(c) Drive Cycles and Weightings

In Phase 1, the agencies adopted three drive cycles used in GEM to evaluate the fuel consumption and CO_2 emissions from various vehicle configurations. One of the cycles is the Transient mode of the California ARB Heavy Heavy-Duty Truck 5 Mode cycle. It is intended to broadly cover urban driving. The other two cycles represent highway driving at 55 mph and 65 mph.

The agencies propose to maintain the existing drive cycles and weighting. For sleeper cabs, the weightings would remain 5 percent of the Transient cycle, 9 percent of the 55 mph cycle, and 86 percent of the 65 mph cycle. The day cab results would be weighted based on 19 percent of the transient cycle, 17 percent of the 55 mph cycle, and 64 percent of the 65 mph cycle (see 40 CFR 1037.510(c)). One key difference in the proposed drive cycles is the addition of grade, discussed below in Section III.E.2.

The 55 mph and 65 mph drive cycles used in GEM assume constant speed operation at nominal vehicle speeds with downshifting occurring if road incline causes a predetermined drop in vehicle speed. In real-world vehicle operation, traffic conditions and other factors may cause periodic operation at lower (*e.g.* creep) or variable vehicle speeds. The agencies therefore request comment on the need to include segments of lower or variable speed operation in the nominally 55 mph and 65 mph drive cycles used in GEM and how this may or may not impact the strategies manufacturers would develop. We also request data from fleet operators or others that may track vehicle speed operation of heavy-duty tractors.

(d) Empty Weight and Payload

The total weight of the tractor-trailer combination is the sum of the tractor curb weight, the trailer curb weight, and the payload. The total weight of a vehicle is important because it in part determines the impact of technologies, such as rolling resistance, on GHG emissions and fuel consumption. In Phase 2, we are proposing to carry over the total weight of the tractor-trailer combination used in GEM for Phase 1. The agencies developed the proposed tractor curb weight inputs for Phase 2 from actual tractor weights measured in two of EPA's Phase 1 test programs. The proposed trailer curb weight inputs were derived from actual trailer weight measurements conducted by EPA and from weight data provided to ICF International by the trailer manufacturers.[174]

There is a further issue of what payload weight to assign during compliance testing. In use, trucks operate at different weights at different times during their operations. The greatest freight transport efficiency (the amount of fuel required to move a ton of payload) would be achieved by operating trucks at the maximum load for which they are designed all of the time. However, this may not always be practicable. Delivery logistics may dictate partial loading. Some payloads, such as potato chips, may fill the trailer before it reaches the vehicle's maximum weight limit. Or full loads simply may not be available commercially. M.J. Bradley analyzed the Truck Inventory and Use Survey and found that approximately 9 percent of combination tractor miles travelled empty, 61 percent are ''cubed-out'' (the trailer is full before the weight limit is reached), and 30 percent are ''weighed out'' (operating weight equal 80,000 lbs which is the gross vehicle weight limit on the Federal Interstate Highway System or greater than 80,000 lbs for vehicles traveling on roads outside of the interstate system).[175]

The amount of payload that a tractor can carry depends on the category (or GVWR and GCWR) of the vehicle. For example, a typical Class 7 tractor can carry less payload than a Class 8 tractor. For Phase 1, the agencies used the Federal Highway Administration Truck Payload Equivalent Factors using Vehicle Inventory and Use Survey (VIUS) and Vehicle Travel Information System data to determine the payloads. FHWA's results indicated that the average payload of a Class 8 vehicle ranged from 36,247 to 40,089 lbs, depending on the average distance travelled per day.[176] The same study shows that Class 7 vehicles carried between 18,674 and 34,210 lbs of payload also depending on average distance travelled per day. Based on

[174] ICF International. Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for Heavy-Duty On-road Vehicles. July 2010. Pages 4–15. Docket Number EPA–HQ–OAR–2010–0162–0044.

[175] M.J. Bradley & Associates. Setting the Stage for Regulation of Heavy-Duty Vehicle Fuel Economy and GHG Emissions: Issues and Opportunities. February 2009. Page 35. Analysis based on 1992 Truck Inventory and Use Survey data, where the survey data allowed developing the distribution of loads instead of merely the average loads.

[176] The U.S. Federal Highway Administration. Development of Truck Payload Equivalent Factor. Table 11. Last viewed on March 9, 2010 at *http://ops.fhwa.dot.gov/freight/freight_analysis/faf/faf2_reports/reports9/s510_11_12_tables.htm.*

these data, the agencies are proposing to continue to prescribe a fixed payload of 25,000 lbs for Class 7 tractors and 38,000 lbs for Class 8 tractors for certification testing. The agencies propose to continue to use a common payload for Class 8 day cabs and sleeper cabs as a predefined GEM input because the data available do not distinguish among Class 8 tractor types. These proposed payload values represent a heavily loaded trailer, but not maximum GVWR, since as described above the majority of tractors ''cube-out'' rather than ''weigh-out.''

Details of the proposed individual weight inputs by regulatory category, as shown in Table III–30, are included in draft RIA Chapter 3. We welcome comment or new data to support changes to the tractor weights, or refinements to the heavy-haul tractor, trailer, and payload weights.

TABLE III–30—PROPOSED COMBINATION TRACTOR WEIGHT INPUTS

Model type	Regulatory subcategory	Tractor tare weight (lbs)	Trailer weight (lbs)	Payload (lbs)	Total weight (lbs)
Class 8	Sleeper Cab High Roof	19,000	13,500	38,000	70,500
Class 8	Sleeper Cab Mid Roof	18,750	10,000	38,000	66,750
Class 8	Sleeper Cab Low Roof	18,500	10,500	38,000	67,000
Class 8	Day Cab High Roof	17,500	13,500	38,000	69,000
Class 8	Day Cab Mid Roof	17,100	10,000	38,000	65,100
Class 8	Day Cab Low Roof	17,000	10,500	38,000	65,500
Class 7	Day Cab High Roof	11,500	13,500	25,000	50,000
Class 7	Day Cab Mid Roof	11,100	10,000	25,000	46,100
Class 7	Day Cab Low Roof	11,000	10,500	25,000	46,500
Class 8	Heavy-Haul	19,000	13,500	86,000	118,500

(e) Tire Testing

In Phase 1, the manufacturers are required to input their tire rolling resistance coefficient into GEM. Also in Phase 1, the agencies adopted the provisions in ISO 28580 to determine the rolling resistance of tires. As described in 40 CFR 1037.520(c), the agencies require that at least three tires for each tire design are to be tested at least one time. Our assessment of the Phase 1 program to date indicates that these requirements reasonably balance the need for precision, repeatability, and testing burden. Therefore we propose to carry over the Phase 1 testing provisions for tire rolling resistance into Phase 2. We welcome comments regarding the proposed tire testing provisions.

In Phase 1, the agencies received comments from stakeholders highlighting a need to develop a reference lab and alignment tires for the HD sector. The agencies discussed the lab-to-lab comparison conducted in the Phase 1 EPA tire test program (76 FR 57184). The agencies reviewed the rolling resistance data from the tires that were tested at both the STL and Smithers laboratories to assess inter-laboratory and test machine variability. The agencies conducted statistical analysis of the data to gain better understanding of lab-to-lab correlation and developed an adjustment factor for data measured at each of the test labs. Based on these results, the agencies believe the lab-to-lab variation for the STL and Smithers laboratories would have very small effect on measured rolling resistance values. Based on the test data, the agencies judge for the HD Phase 2 program to continue to use the current levels of variability, and the agencies therefore propose to allow the use of either Smithers or STL laboratories for determining the tire rolling resistance value. However, we welcome comment on the need to establish a reference machine for the HD sector and whether tire testing facilities are interested in and willing to commit to developing a reference machine.

(2) Key Differences in HD Phase 2 Compliance Provisions

We welcome comment on all aspects of the compliance program for which we are proposing changes.

(a) Aerodynamic Assessment

In Phase 1, the manufacturers conduct aerodynamic testing to establish the appropriate bin and GEM input for determining compliance with the CO_2 and fuel consumption standards. The agencies propose to continue this general approach in HD Phase 2, but make several enhancements to the aerodynamic assessment of tractors. As discussed below in this section, we propose some modifications to the aerodynamic test procedures—the addition of wind averaged yaw in the aerodynamic assessment, the addition of trailer skirts to the standard trailer used to determine aerodynamic performance of tractors and revisions to the aerodynamic bins.

(i) Aerodynamic Test Procedures

The aerodynamic drag of a vehicle is determined by the vehicle's coefficient of drag (Cd), frontal area, air density and speed. Quantifying tractor aerodynamics as an input to the GEM presents technical challenges because of the proliferation of tractor configurations, and subtle variations in measured aerodynamic values among various test procedures. In Phase 1, Class 7 and 8 tractor aerodynamic results are developed by manufacturers using a range of techniques, including wind tunnel testing, computational fluid dynamics, and constant speed tests.

We continue to believe a broad approach allowing manufacturers to use these multiple test procedures to demonstrate aerodynamic performance of its tractor fleet is appropriate given that no single test procedure is superior in all aspects to other approaches. However, we also recognize the need for consistency and a level playing field in evaluating aerodynamic performance. To address the consistency and level playing field concerns, NHTSA and EPA adopted in Phase 1, while working with industry, an approach that identified a reference aerodynamic test method and a procedure to align results from other aerodynamic test procedures with the reference method.

The agencies adopted in Phase 1 an enhanced coastdown procedure as the reference method (see 40 CFR 1066.310) and defined a process for manufacturers to align drag results from each of their own test methods to the reference method results using Falt-aero (see 40 CFR 1037.525). Manufacturers are able to use any aerodynamic evaluation method in demonstrating a vehicle's aerodynamic performance as long as the method is aligned to the reference method. The agencies propose to continue to use this alignment method approach to maintain the testing flexibility that manufacturers have today. However, the agencies propose to increase the rigor in determining the Falt-aero for Phase 2. Beginning in 2021 MY, we propose that the manufacturers would be required to determine a new Falt-aero for each of their tractor models for each aerodynamic test method. In Phase 1, manufacturers are required to determine their Falt-aero using only a high roof sleeper cab with a full aerodynamics package (see 40 CFR 1037.521(a)(2) and proposed 40 CFR 1037.525(b)(2)). In Phase 2, we propose that manufacturers would be required to determine a unique Falt-aero value for each major model of their high roof day cabs and high roof sleeper cabs. In Phase 2, we propose that manufacturers may carry over the Falt-aero value until a model changeover or based on the agencies' discretion to require up to six new Falt-aero determinations each year. We welcome comment on the burden associated with this proposed change to conduct up to six coastdown tests per year per manufacturer.

Based on feedback received during the development of Phase 1, we understand that there is interest from some manufacturers to change the reference method in Phase 2 from coastdown to constant speed testing. EPA has conducted an aerodynamic test program at Southwest Research Institute to evaluate both methods in terms of cost of testing, testing time, testing facility requirements, and repeatability of results. Details of the analysis and results are included in draft RIA Chapter 3.2. The results showed that the enhanced coastdown test procedures and analysis produced results with acceptable repeatability and at a lower cost than the constant speed testing. Based on the results of this testing, the agencies propose to continue to use the enhanced coastdown procedure for the reference method in Phase 2.[177] However, we welcome comment on the need to change the reference method for the Phase 2 final rule to constant speed testing, including comparisons of aerodynamic test results using both the coastdown and constant speed test procedures. In addition, we welcome comments on and suggested revisions to the constant speed test procedure specifications set forth in Chapter 3.2.2.2 of the draft RIA and 40 CFR 1037.533. If we determine that it is appropriate to make the change, then the aerodynamic bins in the final rule would be adjusted to take into account the difference in absolute CdA values due to the change in method.

The agencies are also considering refinements to the computational fluid dynamics modeling method to determine the aerodynamic performance of tractors. Specifically, we are considering whether the conditions for performing the analysis require greater specificity (*e.g.,* wind speed and direction inclusion, turbulence intensity criteria value) or if turbulence model and mesh deformation should be required, rather than ''if applicable,'' for all CFD analysis.[178] The agencies welcome comment on the proposed revisions.

In Phase 1, we adopted interim provisions in 40 CFR 1037.150(k) that accounted for coastdown measurement variability by allowing a compliance demonstration based on in-use test results if the drag area was at or below the maximum drag area allowed for the bin above the bin to which the vehicle was certified. Since adoption of Phase 1, EPA has conducted in-use aerodynamic testing and found that uncertainty associated with coastdown testing is less than anticipated.[179] In addition, we are proposing additional enhancements in the Phase 2 coastdown procedures to continue to reduce the variability of coastdown results, including the impact of environmental conditions. Therefore, we are proposing to sunset the provision in 40 CFR 1037.150(k) at the end of the Phase 1 program (after the 2020 model year). We request comment on whether or not we should factor in a test variability compliance margin into the aerodynamic test procedure, and therefore request data on aerodynamic test variability.

(ii) Wind Averaged Drag

In Phase 1, EPA and NHTSA recognized that wind conditions, most notably wind direction, have a greater impact on real world CO_2 emissions and fuel consumption of heavy-duty trucks than of light-duty vehicles.[180] As noted in the NAS report, the wind average drag coefficient is about 15 percent higher than the zero degree coefficient of drag.[181] In addition, the agencies received comments in Phase 1 that supported the use of wind averaged drag results for the aerodynamic determination. The agencies considered adopting the use of a wind averaged drag coefficient in the Phase 1 regulatory program, but ultimately decided to finalize drag values which represent zero yaw (*i.e.,* representing wind from directly in front of the vehicle, not from the side) instead. We took this approach recognizing that the reference method is coastdown testing and it is not capable of determining wind averaged yaw.[182] Wind tunnels and CFD are currently the only tools to accurately assess the influence of wind speed and direction on a truck's aerodynamic performance. The agencies recognized, as NAS did, that the results of using the zero yaw approach may result in fuel consumption predictions that are offset slightly from real world performance levels, not unlike the offset we see today between fuel economy test results in the CAFE program and actual fuel economy performance observed in-use.

As the tractor manufacturers continue to refine the aerodynamics of tractors, we believe that continuing the zero yaw approach into Phase 2 could potentially impact the overall technology effectiveness or change the kinds of technology decisions made by the tractor manufacturers in developing equipment to meet our proposed HD Phase 2 standards. Therefore, we are proposing aerodynamic test procedures that take into account the wind averaged drag performance of tractors. The agencies propose to account for this change in aerodynamic test procedure by appropriately adjusting the aerodynamic bins to reflect a wind averaged drag result instead of a zero yaw result.

The agencies propose that beginning in 2021 MY, the manufacturers would be required to adjust their CdA values to represent a zero yaw value from coastdown and add the CdA impact of the wind averaged drag. The impact of wind averaged drag relative to a zero yaw condition can only be measured in a wind tunnel or with CFD. We welcome data evaluating the consistency of wind averaged drag measurements between wind tunnel, CFD, and other potential methods such as constant speed or coastdown. The agencies propose that manufacturers would use the following equation to make the necessary adjustments to a coastdown result to obtain the CdA_{wad} value:

$$CdA_{wad} = CdA_{zero,coastdown} + (CdA_{wad,wind\ tunnel} - CdA_{zero,wind\ tunnel}) * F_{alt\text{-}aero}$$

If the manufacturer has a wind averaged CdA value from either a wind tunnel or CFD, then we propose they

[177] Southwest Research Institute. ''Heavy Duty Class 8 Truck Coastdown and Constant Speed Testing.'' April 2015.

[178] 40 CFR 1037.531 ''Computational fluid dynamics (CFD)''.

[179] Southwest Research Institute. ''Heavy Duty Class 8 Truck Coastdown and Constant Speed Testing.'' April 2015.

[180] See 2010 NAS Report, page 95

[181] *See* 2010 NAS Report, Finding 2–4 on page 39. Also see 2014 NAS Report, Recommendation 3.5.

[182] See 2010 NAS Report. Page 95.

would use the following equation to obtain the CdAwad value:

$$CdA_{wad} = CdA_{wad,wind\ tunnel\ or\ CFD} * F_{alt\text{-}aero}$$

We welcome comment on whether the wind averaged drag should be determined using a full yaw sweep as specified in Appendix A of the Society of Automotive Engineers (SAE) recommended practice number J1252 ''SAE Wind Tunnel Test Procedure for Trucks and Buses'' (*e.g.,* zero degree yaw and a six other yaw angles at increments of 3 degrees or greater) or a subset of specific angles as currently allowed in the Phase 1 regulations.[183]

To reduce the testing burden the agencies propose that manufacturers have the option of determining the offset between zero yaw and wind averaged yaw either through testing or by using the EPA-defined default offset. Details regarding the determination of the offset are included in the draft RIA Chapter 3.2. We propose the manufacturers would use the following equation if they had a zero yaw coastdown value and choose not to conduct wind averaged measurements.

$$CdA_{wad} = CdA_{zero,coastdown} + 0.80$$

In addition, we propose the manufacturers would use the following equation if they had a zero yaw wind tunnel or CFD value and choose not to conduct wind averaged measurements.

$$CdA_{wad} = (CdA_{zero,wind\ tunnel\ or\ CFD} * F_{alt\text{-}aero})+0.80$$

We welcome comments on all aspects of the proposed wind averaged drag provisions.

(iii) Standard Trailer Definition

Similar to the approach the agencies adopted in Phase 1, NHTSA and EPA are proposing provisions such that the tractor performance in GEM is judged assuming the tractor is pulling a standardized trailer.[184] The agencies believe that an assessment of the tractor fuel consumption and CO_2 emissions should be conducted using a tractor-trailer combination, as tractors are invariably used in combination with trailers and this is their essential commercial purpose. Trailers, of course, also influence the extent of carbon emissions from the tractor (and vice-versa). We believe that using a standardized trailer best reflects the impact of the overall weight of the tractor-trailer and the aerodynamic technologies in actual use, and consequent real-world performance, where tractors are designed and used with a trailer. EPA research confirms what one would intuit: tractor-trailer pairings are almost always optimized. EPA conducted an evaluation of over 4,000 tractor-trailer combinations using live traffic cameras in 2010.[185] The results showed that approximately 95 percent of the tractors were matched with the standard trailer specified (high roof tractor with box trailer, mid roof tractor with tanker trailer, and low roof with flatbed trailer). Therefore, the agencies propose that Phase 2 GEM continue to use a predefined typical trailer defined in Phase 1 in assessing overall performance for test purposes. As such, the high roof tractors would be paired with a standard box trailer; the mid roof tractors would be paired with a tanker trailer; and the low roof tractors would be paired with a flatbed trailer.

However, the agencies are proposing to change the definition of the standard box trailer used by tractor manufacturers to determine the aerodynamic performance of high roof tractors in Phase 2. We believe this is necessary to reflect the aerodynamic improvements experienced by the trailer fleet over the last several years due to influences from the California Air Resources Board mandate[186] and EPA's SmartWay Transport Partnership. The standard box trailer used in Phase 1 to assess the aerodynamic performance of high roof tractors is a 53 foot box trailer without any aerodynamic devices. In the development of Phase 2, the agencies evaluated the increase in adoption rates of trailer side skirts and boat tails in the market over the last several years and have seen a marked increase. We estimate that approximately 50 percent of the new trailers sold in 2018 will have trailer side skirts.[187] [188] As the agencies look towards the proposed standards in the 2021 and beyond timeframe, we believe that it is appropriate to update the standard box trailer definition. In 2021–2027, we believe the trailer fleet will be a mix of trailers with no aerodynamics, trailers with skirts, and trailers with advanced aero; with the advanced aero being a very limited subset of the new trailers sold each year. Consequently, overall, we believe a trailer with a skirt will be the most representative of the trailer fleet for the duration of the regulation timeframe, and plausibly beyond. Therefore, we are proposing that the standard box trailer in Phase 2—the trailer assumed during the certification process to be paired with a high roof tractor—be updated to include a trailer skirt starting in 2021 model year. Even though the agencies are proposing new box trailer standards beginning in 2018 MY, we are not proposing to update the standard trailer in the tractor certification process until 2021 MY, to align with the new tractor standards. If we were to revise the standardized trailer definition for Phase 1, then we would need to revise the Phase 1 tractor standards. The details of the trailer skirt definition are included in 40 CFR 1037.501(g)(1).

EPA has conducted extensive aerodynamic testing to quantify the impact on the coefficient of drag of a high roof tractor due to the addition of a trailer skirt. Details of the test program and the results can be found in the draft RIA Chapter 3.2. The results of the test program indicate that on average, the impact of a trailer skirt matching the definition of the skirt specified in 40 CFR 1037.501(g)(1) is approximately 8 percent improvement in coefficient of drag area. This off-set was used during the development of the Phase 2 aerodynamic bins.

We seek comment on our proposed HD Phase 2 standard trailer configuration. We also welcome comments on suggestions on alternative ways to define the standard trailer, such as developing a certified computer aided drawing (CAD) model.

(iv) Aerodynamic Bins

The agencies are proposing to continue the approach where the manufacturer would determine a tractor's aerodynamic drag force through testing, determine the appropriate predefined aerodynamic bin, and then input the predefined CdA value for that bin into the GEM. The agencies proposed Phase 2 aerodynamic bins reflect three changes to the Phase 1 bins—the incorporation of wind averaged drag, the addition of trailer skirts to the standard box trailer used to determine the aerodynamic performance of high roof tractors, and the addition of bins to reflect the continued improvement of tractor aerodynamics in the future. Because of each of these changes, the aerodynamic bins proposed for Phase 2 are not directly comparable to the Phase 1 bins.

HD Phase 1 included five aerodynamic bins to cover the spectrum of aerodynamic performance of high

[183] Proposed 40 CFR 1037.525(d)(2); ''Yaw Sweep Corrections''.

[184] See 40 CFR 1037.501(g).

[185] See Memo to Docket, Amy Kopin. ''Truck and Trailer Roof Match Analysis.'' August 2010.

[186] California Air Resources Board. Tractor-Trailer Greenhouse Gas regulation. Last viewed on September 4, 2014 at *http://www.arb.ca.gov/msprog/truckstop/trailers/trailers.htm.*

[187] Ben Sharpe (ICCT) and Mike Roeth (North American Council for Freight Efficiency), ''Costs and Adoption Rates of Fuel-Saving Technologies for Trailer in the North American On-Road Freight Sector'', Feb 2014.

[188] Frost & Sullivan, ''Strategic Analysis of North American Semi-trailer Advanced Technology Market'', Feb 2013.

roof tractors. Since the development of the Phase 1 rules, the manufacturers have continued to invest in aerodynamic improvements for tractors. This continued evolution of aerodynamic performance, both in production and in the research stage as part of the SuperTruck program, has consequently led the agencies to propose two additional aerodynamic technology bins (Bins VI and VII) for high roof tractors. These two new bins would further segment the Phase 1 aerodynamic Bin V to recognize the difference in advanced aerodynamic technologies and designs.

In both HD Phase 1 and as proposed by the agencies in Phase 2, aerodynamic Bin I through Bin V represent tractors sharing similar levels of technology. The first high roof aerodynamic category, Bin I, is designed to represent tractor bodies which prioritize appearance or special duty capabilities over aerodynamics. These Bin I tractors incorporate few, if any, aerodynamic features and may have several features that detract from aerodynamics, such as bug deflectors, custom sunshades, B-pillar exhaust stacks, and others. The second high roof aerodynamics category is Bin II which roughly represents the aerodynamic performance of the average new tractor sold in 2010. The agencies developed this bin to incorporate conventional tractors which capitalize on a generally aerodynamic shape and avoid classic features which increase drag. High roof tractors within Bin III build on the basic aerodynamics of Bin II tractors with added components to reduce drag in the most significant areas on the tractor, such as integral roof fairings, side extending gap reducers, fuel tank fairings, and streamlined grill/hood/mirrors/bumpers, similar to 2013 model year SmartWay tractors. The Bin IV aerodynamic category for high roof tractors builds upon the Bin III tractor body with additional aerodynamic treatments such as underbody airflow treatment, down exhaust, and lowered ride height, among other technologies. HD Phase 1 Bin V tractors incorporate advanced technologies which are currently in the prototype stage of development, such as advanced gap reduction, rearview cameras to replace mirrors, wheel system streamlining, and advanced body designs. For HD Phase 2, the agencies propose to segment the aerodynamic performance of these advanced technologies into Bins V through VII.

In Phase 1, the agencies adopted only two aerodynamic bins for low and mid roof tractors. The agencies limited the number of bins to reflect the actual range of aerodynamic technologies effective in low and mid roof tractor applications. High roof tractors are consistently paired with box trailer designs, and therefore manufacturers can design the tractor aerodynamics as a tractor-trailer unit and target specific areas like the gap between the tractor and trailer. In addition, the high roof tractors tend to spend more time at high speed operation which increases the impact of aerodynamics on fuel consumption and GHG emissions. On the other hand, low and mid roof tractors are designed to pull variable trailer loads and shapes. They may pull trailers such as flat bed, low boy, tankers, or bulk carriers. The loads on flat bed trailers can range from rectangular cartons with tarps, to a single roll of steel, to a front loader. Due to these variables, manufacturers do not design unique low and mid roof tractor aerodynamics but instead use derivatives from their high roof tractor designs. The aerodynamic improvements to the bumper, hood, windshield, mirrors, and doors are developed for the high roof tractor application and then carried over into the low and mid roof applications. As mentioned above, the types of designs that would move high roof tractors from a Bin III to Bins IV through VII include features such as gap reducers and integral roof fairings which would not be appropriate on low and mid roof tractors.

As Phase 2 looks to further improve the aerodynamics for high roof sleeper cabs, we believe it is also appropriate to expand the number of bins for low and mid roof tractors too. For Phase 2, the agencies are proposing to differentiate the aerodynamic performance for low and mid roof applications with four bins, instead of two, in response to feedback received from manufacturers of low and mid roof tractors related to the limited opportunity to incorporate aerodynamic technologies in their compliance plan. We propose that low and mid roof tractors may determine the aerodynamic bin based on the aerodynamic bin of an equivalent high roof tractor, as shown below in Table III–31.

TABLE III–31—PROPOSED PHASE 2 REVISIONS TO 40 CFR 1037.520(B)(3)

High roof bin	Low and mid roof bin
Bin I	Bin I
Bin II	Bin I
Bin III	Bin II
Bin IV	Bin II
Bin V	Bin III
Bin VI	Bin III
Bin VII	Bin IV

The agencies developed new high roof tractor aerodynamic bins for Phase 2 that reflect the change from zero yaw to wind averaged drag, the more aerodynamic reference trailer, and the addition of two bins. Details regarding the derivation of the proposed high roof bins are included in Draft RIA Chapter 3.2.8. The proposed high roof tractor bins are defined in Table III–32. The proposed revisions to the low and mid roof tractor bins reflect the addition of two new aerodynamic bins and are listed in Table III–33.

TABLE III–32—PROPOSED PHASE 2 AERODYNAMIC INPUT DEFINITIONS TO GEM FOR HIGH ROOF TRACTORS

	Class 7	Class 8	
	Day cab	Day cab	Sleeper cab
	High roof	High roof	High roof
Aerodynamic Test Results (CdA_{wad} in m²)			
Bin I	≥7.5	≥7.5	≥7.3
Bin II	6.8–7.4	6.8–7.4	6.6–7.2
Bin III	6.2–6.7	6.2–6.7	6.0–6.5
Bin IV	5.6–6.1	5.6–6.1	5.4–5.9
Bin V	5.1–5.5	5.1–5.5	4.9–5.3
Bin VI	4.7–5.0	4.7–5.0	4.5–4.8
Bin VII	≤4.6	≤4.6	≤4.4

TABLE III–32—PROPOSED PHASE 2 AERODYNAMIC INPUT DEFINITIONS TO GEM FOR HIGH ROOF TRACTORS—Continued

	Class 7	Class 8	
	Day cab	Day cab	Sleeper cab
	High roof	High roof	High roof
Aerodynamic Input to GEM (CdA_{wad} in m^2)			
Bin I	7.6	7.6	7.4
Bin II	7.1	7.1	6.9
Bin III	6.5	6.5	6.3
Bin IV	5.8	5.8	5.6
Bin V	5.3	5.3	5.1
Bin VI	4.9	4.9	4.7
Bin VII	4.5	4.5	4.3

TABLE III–33—PROPOSED PHASE 2 AERODYNAMIC INPUT DEFINITIONS TO GEM FOR LOW AND MID ROOF TRACTORS

	Class 7		Class 8			
	Day cab		Day cab		Sleeper cab	
	Low roof	Mid roof	Low roof	Mid roof	Low roof	Mid roof
Aerodynamic Test Results (CdA in m^2)						
Bin I	≥5.1	≥6.5	≥5.1	≥6.5	≥5.1	≥6.5
Bin II	4.6–5.0	6.0–6.4	4.6–5.0	6.0–6.4	4.6–5.0	6.0–6.4
Bin III	4.2–4.5	5.6–5.9	4.2–4.5	5.6–5.9	4.2–4.5	5.6–5.9
Bin IV	≤4.1	≤5.5	≤4.1	≤5.5	≤4.1	≤5.5
Aerodynamic Input to GEM (CdA in m^2)						
Bin I	5.3	6.7	5.3	6.7	5.3	6.7
Bin II	4.8	6.2	4.8	6.2	4.8	6.2
Bin III	4.3	5.7	4.3	5.7	4.3	5.7
Bin IV	4.0	5.4	4.0	5.4	4.0	5.4

(b) Road Grade in the Drive Cycles

Road grade can have a significant impact on the overall fuel economy of a heavy-duty vehicle. Table III–34 shows the results from a real world evaluation of heavy-duty tractor-trailers conducted by Oak Ridge National Lab.[189] The study found that the impact of a mild upslope of one to four percent led to a decrease in average fuel economy from 7.33 mpg to 4.35 mpg. These results are as expected because vehicles consume more fuel while driving on an upslope than driving on a flat road because the vehicle needs to exert additional power to overcome the grade resistance force.[190] The amount of extra fuel increases with increases in road gradient. On downgrades, vehicles consume less fuel than on a flat road. However, as shown in the fuel consumption results in Table III–34, the amount of increase in fuel consumption on an upslope is greater than the amount of decrease in fuel consumption on a downslope which leads to a net increase in fuel consumption. As an example, the data shows that a vehicle would use 0.3 gallons per mile more fuel in a severe upslope than on flat terrain, but only save 0.1 gallons of fuel per mile on a severe downslope. In another study, Southwest Research Institute modeling found that the addition of road grade to a drive cycle has an 8 to 10 percent negative impact on fuel economy.[191]

TABLE III–34—FUEL CONSUMPTION RELATIVE TO ROAD GRADE

Type of terrain	Average fuel economy (miles per gallon)	Average fuel consumption (gallons per mile)
Severe upslope (>4%)	2.90	0.34
Mild upslope (1% to 4%)	4.35	0.23
Flat terrain (1% to 1%)	7.33	0.14
Mild downslope (−4% to −1%)	15.11	0.07
Severe downslope (<−4%)	23.50	0.04

[189] Oakridge National Laboratory. Transportation Energy Book, Edition 33. Table 5.10 Effect of Terrain on Class 8 Truck Fuel Economy. 2014. Last accessed on September 19, 2014 at *http://cta.ornl.gov/data/Chapter5.shtml*.

[190] Ibid.

[191] Reinhart, T. (2015). *Commercial Medium- and Heavy-Duty (MD/HD) Truck Fuel Efficiency Technology Study—Report #2*. Washington, DC: National Highway Traffic Safety Administration.

In Phase 1, the agencies did not include road grade. However, we believe it is important to propose including road grade in Phase 2 to properly assess the value of technologies, such as downspeeding and the integration of the engine and transmission, which were not technologies included in the technology basis for Phase 1 and are not directly assessed by GEM in its Phase 1 iteration. The addition of road grade to the drive cycles would be consistent with the NAS recommendation in the 2014 Phase 2 First Report.[192]

The U.S. Department of Energy and EPA have partnered to support a project aimed at evaluating, refining and/or developing the appropriate road grade profiles for the 55 mph and 65 mph highway cruise duty cycles that would be used in the certification of heavy-duty vehicles to the Phase 2 GHG emission and fuel efficiency standards. The National Renewable Energy Laboratory (NREL) was contracted to do this work and has since developed two pairs of candidate, activity-weighted road grade profiles representative of U.S. limited-access highways. To this end, NREL used high-accuracy road grade data and county-specific vehicle miles traveled data. One pair of the profiles is representative of the nation's limited-access highways with 55 and 60 mph speed limits, and another is representative of such highways with speed limits of 65 to 75 mph. The profiles are distance-based and cover a maximum distance of 12 and 15 miles, respectively. A report documenting this NREL work is in the public docket for these proposed rules, and comments are requested on the recommendations therein.[193] In addition to NREL work, the agencies have independently developed yet another candidate road grade profile for use in the 55 mph and 65 mph highway cruise duty cycles. While based on the same road grade database generated by NREL for U.S. restricted-access highways, its design is predicated on a different approach. The development of this profile is documented in the memorandum to the docket.[194] The agencies have evaluated all of the candidate road grade profiles and have prepared possible alternative tractor standards based on these profiles. The agencies request comment on this analysis, which is available in a memorandum to the docket.[195]

For the proposal, the agencies developed an interim road grade profile for development of the proposed standards. The agencies are proposing the inclusion of an interim road grade profile, as shown below in Figure III–2, in both the 55 mph and 65 mph cycles. The grade profile was developed by Southwest Research Institute on a 12.5 mile stretch of restricted-access highway during on-road tests conducted for EPA's validation of the Phase 2 version of GEM.[196] The minimum grade in the interim cycle is −2.1 percent and the maximum grade is 2.4 percent. The cycle spends 30 percent of the distance in grades of +/− 0.5 percent. Overall, the cycle spends approximately 50 percent of the time in relatively flat terrain with road gradients of less than 1 percent.

The agencies believe the interim cycle has sufficient representativeness based on a comparison to data from the Department of Transportation used in the development of the light-duty Federal Test Procedure cycle (FTP), which found approximately 55 percent of the vehicle miles traveled were on road gradients of less than 1 percent.[197] Consequently, we expect that road grade profiles developed by NREL and by the agencies will not differ significantly from the interim profile proposed here. The agencies request data from fleet operators or others that have real world grade profile data.

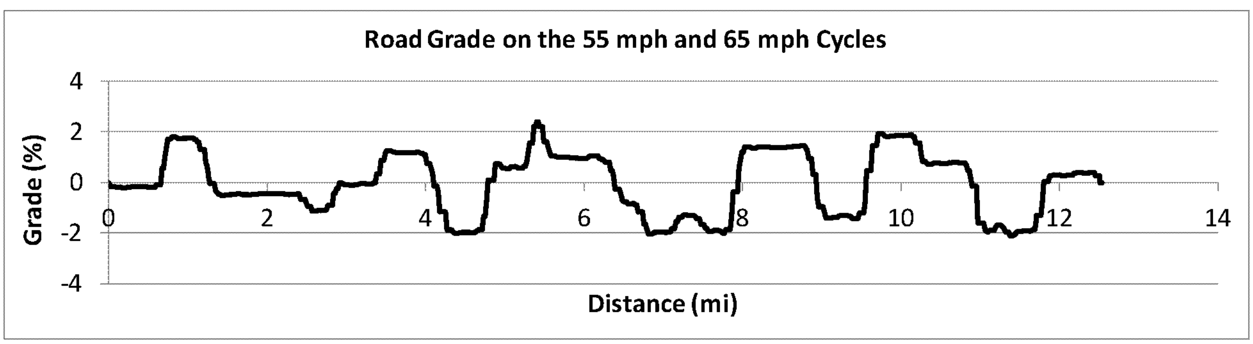

Figure III-2 Proposed Road Grade Profile for 55 mph and 65 mph Drive Cycles

(c) Weight Reduction

In Phase 1, the agencies adopted regulations that provided manufacturers with the ability to use GEM to measure emission reduction and reductions in fuel consumption resulting from use of high strength steel and aluminum components for weight reduction,, and to do so without the burden of entering the curb weight of every tractor produced. We treated such weight reduction in two ways in Phase 1 to account for the fact that combination tractor-trailers weigh-out approximately one-third of the time and cube-out approximately two-thirds of the time. Therefore, one-third of the weight reduction is added payload in the denominator while two-thirds of the weight reduction is subtracted from the overall weight of the vehicle in GEM. See 76 FR 57153. The agencies also allowed manufacturers to petition for off-cycle credits for components not measured in GEM.

NHTSA and EPA propose carrying the Phase 1 treatment of weight reduction into Phase 2. That is, these types of weight reduction, although not part of the agencies' technology packages for

[192] National Academy of Science. ''Reducing the Fuel Consumption and GHG Emissions of Medium- and Heavy-Duty Vehicles, Phase Two, First Report.'' 2014. Recommendation S.3 (3.6).

[193] See NREL Report ''EPA Road Grade profiles'' for DOE–EPA Interagency Agreement to Refine Drive Cycles for GHG Certification of Medium- and Heavy-Duty Vehicles, IA Number DW–89–92402501.

[194] Memorandum dated April 2015 on Possible Tractor, Trailer, and Vocational Vehicle Standards Derived from Alternative Road Grade Profiles.

[195] Ibid.

[196] Southwest Research Institute. ''GEM Validation'', Technical Research Workshop supporting EPA and NHTSA Phase 2 Standards for MD/HD Greenhouse Gas and Fuel Efficiency—December 10 and 11, 2014. Can be accessed at *http://www.epa.gov/otaq/climate/regs-heavy-duty.htm.*

[197] U.S. EPA. FTP Preliminary Report. May 14, 1993. Table 5–1, page 76. EPA–420–R–93–007.

the proposed (or alternative) standards, can still be recognized in GEM up to a point. In addition, the agencies propose to add additional thermoplastic components to the weight reduction table, as shown below in Table III–35. The thermoplastic component weight reduction values were developed in coordination with SABIC, a thermoplastic component supplier. Also, in Phase 2, we are proposing to recognize the potential weight reduction opportunities in the powertrain and drivetrain systems as part of the vehicle inputs into GEM. Therefore, we believe it is appropriate to also recognize the weight reduction associated with both smaller engines and 6x2 axles.[198] We propose including the values listed in Table III–36 and make them available upon promulgation of the final Phase 2 rules (*i.e.,* available even under Phase 1). We welcome comments on all aspects of weight reduction.

TABLE III–35—PROPOSED PHASE 2 WEIGHT REDUCTION TECHNOLOGIES FOR TRACTORS

Weight reduction technology		Weight reduction (lb per tire/wheel)
Single Wide Drive Tire with	Steel Wheel	84
	Aluminum Wheel	139
	Light Weight Aluminum Wheel	147
Steer Tire or Dual Wide Drive Tire with	High Strength Steel Wheel	8
	Aluminum Wheel	21
	Light Weight Aluminum Wheel	30

Weight reduction technologies	Aluminum weight reduction (lb.)	High strength steel weight reduction (lb.)	Thermoplastic weight reduction (lb.)
Door (per door)	20	6	
Roof (per vehicle)	60	18	
Cab rear wall (per vehicle)	49	16	
Cab floor (per vehicle)	56	18	
Hood (per vehicle)	55	17	
Hood Support Structure (per vehicle)	15	3	
Hood and Front Fender (per vehicle)			65
Day Cab Roof Fairing (per vehicle)			18
Sleeper Cab Roof Fairing (per vehicle)	75	20	40
Aerodynamic Side Extender (per vehicle)			10
Fairing Support Structure (per vehicle)	35	6	
Instrument Panel Support Structure (per vehicle)	5	1	
Brake Drums—Drive (per 4)	140	11	
Brake Drums—Non Drive (per 2)	60	8	
Frame Rails (per vehicle)	440	87	
Crossmember—Cab (per vehicle)	15	5	
Crossmember—Suspension (per vehicle)	25	6	
Crossmember—Non Suspension (per 3)	15	5	
Fifth Wheel (per vehicle)	100	25	
Radiator Support (per vehicle)	20	6	
Fuel Tank Support Structure (per vehicle)	40	12	
Steps (per vehicle)	35	6	
Bumper (per vehicle)	33	10	
Shackles (per vehicle)	10	3	
Front Axle (per vehicle)	60	15	
Suspension Brackets, Hangers (per vehicle)	100	30	
Transmission Case (per vehicle)	50	12	
Clutch Housing (per vehicle)	40	10	
Drive Axle Hubs (per 4)	80	20	
Non Drive Front Hubs (per 2)	40	5	
Driveshaft (per vehicle)	20	5	
Transmission/Clutch Shift Levers (per vehicle)	20	4	

TABLE III–36—PROPOSED PHASE 2 WEIGHT REDUCTION VALUES FOR OTHER COMPONENTS

Weight reduction technology	Weight reduction (lb)
6x2 axle configuration in tractors	300
4x2 axle configuration in Class 8 tractors	300
Tractor engine with displacement less than 14.0L	[199]300
CI Liquified Natural Gas tractor	[200][201] −600
SI Compressed Natural Gas tractor	−525

[198] North American Council for Freight Efficiency. ''Confidence Findings on the Potential of 6×2 Axles.'' 2014. Page 16.

TABLE III–36—PROPOSED PHASE 2 WEIGHT REDUCTION VALUES FOR OTHER COMPONENTS—Continued

Weight reduction technology	Weight reduction (lb)
CI Compressed Natural Gas tractor	−900

(d) GEM Inputs

The agencies propose to continue to require the Phase 1 GEM inputs for tractors in Phase 2. These inputs include the following:

- Steer tire rolling resistance,
- Drive tire rolling resistance,
- Coefficient of Drag Area,
- Idle Reduction, and
- Vehicle Speed Limiter.

As discussed above in Section II.C and III.D, there are several additional inputs that are proposed for Phase 2. The new GEM inputs proposed for Phase 2 include the following:

- Engine information including manufacturer, model, combustion type, fuel type, family name, and calibration identification
- Engine fuel map,
- Engine full-load torque curve,
- Engine motoring curve,
- Transmission information including manufacturer and model
- Transmission type,
- Transmission gear ratios,
- Drive axle ratio,
- Loaded tire radius for drive tires, and
- Other technology inputs.

The agencies welcome comments on the inclusion of these proposed technologies into GEM in Phase 2.

(e) Vehicle Speed Limiters and Extended Idle Provisions

The agencies received comments during the development of Phase 1 that the Clean Air Act provisions to prevent tampering (CAA section 203(a)(3)(A); 42 U.S.C. 7522(a)(3)(A)) of vehicle speed limiters and extended idle reduction technologies would prohibit their use for demonstrating compliance with the Phase 1 standards. In Phase 1, the agencies adopted provisions to allow for discounted credits for idle reduction technologies that allowed for override conditions and expiring engine shutdown systems (see 40 CFR 1037.660). Similarly, the agencies adopted provisions to allow for ''soft top'' speeds and expiring vehicle speed limiters, and we are not proposing to change those provisions (see 40 CFR 1037.640). However, as we develop Phase 2, we understand that the concerns still exist that the ability for a tractor manufacturer to reflect the use of a VSL in its compliance determination may be constrained by the demand for flexibility in the use of VSLs by the customers. . The agencies welcome suggestions on how to close the gap between the provisions that would be acceptable to the industry while maintaining our need to ensure that modifications do not violate 42 U.S.C. 7522(a)(3)(A). We request comment on potential approaches which would enable feedback mechanism between the vehicle owner/fleet that would provide the agencies the assurance that the benefits of the VSLs will be seen in use but which also provides the vehicle owner/fleet the flexibility they many need during in-use operation. More generally in our discussions with several trucking fleets and with the American Trucking Associations an interest was expressed by the fleets if there was a means by which they could participate in the emissions credit transactions which is currently limited to the directly regulated truck manufacturers. VSLs and extended idle systems were two example technologies that fleets and individual owners can order for a new build truck, and that from the fleet's perspective the truck manufacturers receive emission credits for. The agencies do not have a specific proposal or a position on the request from the American Trucking Association and its members, but we request comment on whether or not it is appropriate to allow owners to participate in the overall compliance process for the directly regulated parties, if such a thing is allowed under the two agencies' respective statutes, and what regulatory provisions would be needed to incorporate such an approach.

(f) Emission Control Labels

The agencies consider it crucial that authorized compliance inspectors are able to identify whether a vehicle is certified, and if so whether it is in its certified condition. To facilitate this identification in Phase 1, EPA adopted labeling provisions for tractors that included several items. The Phase 1 tractor label must include the manufacturer, vehicle identifier such as the Vehicle Identification Number (VIN), vehicle family, regulatory subcategory, date of manufacture, compliance statements, and emission control system identifiers (see 40 CFR 1037.135). In Phase 1, the emission control system identifiers are limited to vehicle speed limiters, idle reduction technology, tire rolling resistance, some aerodynamic components, and other innovative and advanced technologies.

The number of proposed emission control systems for greenhouse gas emissions in Phase 2 has increased significantly. For example, the engine, transmission, drive axle ratio, accessories, tire radius, wind averaged drag, predictive cruise control, and automatic tire inflation system are controls which can be evaluated on-cycle in Phase 2 (*i.e.* these technologies' performance can now be input to GEM), but could not be in Phase 1. Due to the complexity in determining greenhouse gas emissions as proposed in Phase 2, the agencies do not believe that we can unambiguously determine whether or not a vehicle is in a certified condition through simply comparing information that could be made available on an emission control label with the components installed on a vehicle. Therefore, EPA proposes to remove the requirement to include the emission control system identifiers required in 40 CFR 1037.135(c)(6) and in Appendix III to 40 CFR part 1037 from the emission control labels for vehicles certified to the Phase 2 standards. However, the agencies may finalize requirements to maintain some label content to facilitate a limited visual inspection of key vehicle parameters that can be readily observed. Such requirements may be very similar to the labeling requirements from the Phase 1 rulemaking, though we would want to more carefully consider the list of technologies that would allow for the most effective inspection. We request comment on an appropriate list of candidate technologies that would properly balance the need to limit label content with the interest in providing the most useful information for inspectors to confirm that vehicles have been properly built. We are not proposing to modify the existing emission control labels for tractors certified for MYs 2014–2020 (Phase 1) CO_2 standards.

Under the agencies' existing authorities, manufacturers must provide detailed build information for a specific vehicle upon our request. Our expectation is that this information should be available to us via email or other similar electronic communication

[199] Kenworth. ''Kenworth T680 with PACCAR MX–13 Engine Lowers Costs for Oregon Open-Deck Carrier.'' Last viewed on December 16, 2014 at *http://www.kenworth.com/news/news-releases/2013/december/t680-cotc.aspx*.

[200] National Energy Policy Institute. ''What Set of Conditions Would Make the Business Case to Convert Heavy Trucks to Natural Gas?—A Case Study.'' May 1, 2012. Last accessed on December 15, 2014 at *http://www.tagnaturalgasinfo.com/uploads/1/2/2/3/12232668/natural_gas_for_heavy_trucks.pdf*.

[201] Westport presentation (2013). Last accessed on December 15, 2014 at *http://www.westport.com/file_library/files/webinar/2013–06–19_CNGandLNG.pdf*.

on a same-day basis, or within 24 hours of a request at most. We request comment on any practical limitations in promptly providing this information. We also request comment on approaches that would minimize burden for manufacturers to respond to requests for vehicle build information and would expedite an authorized compliance inspector's visual inspection. For example, the agencies have started to explore ideas that would provide inspectors with an electronic method to identify vehicles and access on-line databases that would list all of the engine-specific and vehicle-specific emissions control system information. We believe that electronic and Internet technology exists today for using scan tools to read a bar code or radio frequency identification tag affixed to a vehicle that would then lead to secure on-line access to a database of manufacturers' detailed vehicle and engine build information. Our exploratory work on these ideas has raised questions about the level of effort that would be required to develop, implement and maintain an information technology system to provide inspectors real-time access to this information. We have also considered questions about privacy and data security. We request comment on the concept of electronic labels and database access, including any available information on similar systems that exist today and on burden estimates and approaches that could address concerns about privacy and data security. Based on new information that we receive, we may consider initiating a separate rulemaking effort to propose and request comment on implementing such an approach.

(g) End of Year Reports

In the Phase 1 program, manufacturers participating in the ABT program provided 90 day and 270 day reports to EPA and NHTSA after the end of the model year. The agencies adopted two reports for the initial program to help manufacturers become familiar with the reporting process. For the HD Phase 2 program, the agencies propose to simplify reporting such that manufacturers would only be required to submit the final report 90 days after the end of the model year with the potential to obtain approval for a delay up to 30 days. We are accordingly proposing to eliminate the end of year report, which represents a preliminary set of ABT figures for the preceding year. We welcome comment on this proposed revision.

(h) Special Compliance Provisions

In Phase 2, the agencies propose to consider the performance of the engine, transmission, and drivetrain in determining compliance with the Phase 2 tractor standards. With the inclusion of the engine's performance in the vehicle compliance, EPA proposes to modify the prohibition to introducing into U.S. commerce a tractor containing an engine not certified for use in tractor (see proposed 40 CFR 1037.601(a)(1)). In Phase 2, we no longer see the need to prohibit the use of vocational engines in tractors because the performance of the engine would be appropriately reflected in GEM. We welcome comment on removing this prohibition.

The agencies also propose to change the compliance process for manufacturers seeking to use the off-road exclusion. During the Phase 1 program, manufacturers realized that contacting the agencies in advance of the model year was necessary to determine whether vehicles would qualify for exemption and need approved certificates of conformity. The agencies found that the petition process allowed at the end of the model year was not necessary and that an informal approval during the precertification period was more effective. Therefore, NHTSA is proposing to remove its off-road petitioning process in 49 CFR 535.8 and EPA is proposing to add requirements for informal approvals in 40 CFR 1037.610.

(i) Chassis Dynamometer Testing Requirement

The agencies foresee the need to continue to track the progress of the Phase 2 program throughout its implementation. As discussed in Section II, the agencies expect to evaluate the overall performance of tractors with the GEM results provided by manufacturers through the end of year reports. However, we also need to continue to have confidence in our simulation tool, GEM, as the vehicle technologies continue to evolve. Therefore, EPA proposes that the manufacturers conduct annual chassis dynamometer testing of three sleeper cabs tractor and two day cab tractor and provide the data and the GEM result from each of these two tractor configurations to EPA (see 40 CFR 1037.665). We request comment on the costs and efficacy of this data submission requirement. We emphasize that this program would not be used for compliance or enforcement purposes.

F. Flexibility Provisions

EPA and NHTSA are proposing two flexibility provisions specifically for heavy-duty tractor manufacturers in Phase 2. These are an averaging, banking and trading program for CO_2 emissions and fuel consumption credits, as well as provisions for credits for off-cycle technologies which are not included as inputs to the GEM. Credits generated under these provisions can only be used within the same averaging set which generated the credit.

The agencies are also proposing to remove or modify several Phase 1 interim provisions, as described below.

(1) Averaging, Banking, and Trading (ABT) Program

Averaging, banking, and trading of emission credits have been an important part of many EPA mobile source programs under CAA Title II, and the NHTSA light-duty CAFE program. The agencies also included this flexibility in the HD Phase 1 program. ABT provisions are useful because they can help to address many potential issues of technological feasibility and lead-time, as well as considerations of cost. They provide manufacturers flexibilities that assist in the efficient development and implementation of new technologies and therefore enable new technologies to be implemented at a more aggressive pace than without ABT. A well-designed ABT program can also provide important environmental and energy security benefits by increasing the speed at which new technologies can be implemented. Between MYs 2013 and 2014 all four tractor manufacturers are taking advantage of the ABT provisions in the Phase 1 program. NHTSA and EPA propose to carry-over the Phase 1 ABT provisions for tractors into Phase 2.

The agencies propose to continue the five year credit life and three year deficit carry-over provisions from Phase 1 (40 CFR 1037.740(c) and 1037.745). Please see additional discussion in Section I.C.1.b. Although we are not proposing any additional restrictions on the use of Phase 1 credits, we are requesting comment on this issue. Early indications suggest that positive market reception to the Phase 1 technologies could lead to manufacturers accumulating credits surpluses that could be quite large at the beginning of the proposed Phase 2 program. This appears especially likely for tractors. The agencies are specifically requesting comment on the likelihood of this happening, and whether any regulatory changes would be appropriate. For example, should the agencies limit the amount of credits than could be carried over from Phase 1 or limit them to the first year or two of the Phase 2 program? Also, if we determine that large surpluses are likely, how should that factor into our decision on the feasibility of more stringent standards in MY 2021?

We welcome comments on these proposed flexibilities and are interested in information that may indicate doing as proposed could distort the heavy-duty vehicle market.

(2) Off-Cycle Technology Credits

In Phase 1, the agencies adopted an emissions and fuel consumption credit generating opportunity that applied to innovative technologies that reduce fuel consumption and CO_2 emissions. These technologies were required to not be in common use with heavy-duty vehicles before the 2010MY and not reflected in the GEM simulation tool (*i.e.,* the benefits are ''off-cycle''). See 76 FR 57253. The agencies propose to largely continue, but redesignate the Phase 1 innovative technology program as part of the off-cycle program for Phase 2. In other words, beginning in 2021 MY all technologies that are not fully accounted for in the GEM simulation tool, or by compliance dynamometer testing could be considered off-cycle, including those technologies that may have been considered innovative technologies in Phase 1 of the program. The agencies propose to maintain the requirement that, in order for a manufacturer to receive credits for Phase 2, the off-cycle technology would still need to meet the requirement that it was not in common use prior to MY 2010. For additional information on the treatment of off-cycle technologies see Section I.C.1.c.

The agencies are proposing a split process for handling off-cycle technologies in Phase 2. First, there is a set of predefined off-cycle technologies that are entering the market today, but could be fully-recognized in our proposed HD Phase 2 certification procedures. Examples of such technologies include predictive cruise control, 6x2 axles, axle lubricants, automated tire inflation systems, and air conditioning efficiency improvements. For these technologies, the agencies propose to define the effectiveness value of these technologies similar to the approach taken in the MY2017–2025 light-duty rule (see 77 FR 62832–62840 (October 15, 2012)). These default effectiveness values could be used as valid inputs to Phase 2 GEM. The proposed effectiveness value of each technology is discussed above in Section III.D.2.

The agencies also recognize that there are emerging technologies today that are being developed, but would not be accounted for in the GEM inputs, therefore would be considered off-cycle. These technologies could include systems such as efficient steering systems, cooling fan optimization, and further tractor-trailer integration. These off-cycle technologies could include known, commercialized technologies if they are not yet widely utilized in a particular heavy-duty sector subcategory. Any credits for these technologies would need to be based on real-world fuel consumption and GHG reductions that can be measured with verifiable test methods using representative driving conditions typical of the engine or vehicle application.

The agencies propose that the approval for Phase 1 innovative technology credits (approved prior to 2021 MY) would be carried into the Phase 2 program on a limited basis for those technologies where the benefit is not accounted for in the Phase 2 test procedure. Therefore, the manufacturers would not be required to request new approval for any innovative credits carried into the off-cycle program, but would have to demonstrate the new cycle does not account for these improvements beginning in the 2021 MY. The agencies believe this is appropriate because technologies, such as those related to the transmission or driveline, may no longer be ''off-cycle'' because of the addition of these technologies into the Phase 2 version of GEM. The agencies also seek comments on whether off-cycle technologies in the Phase 2 program should be limited by infrequent common use and by what model years, if any. We also seek comments on an appropriate penetration rate for a technology not to be considered in common use.

As in Phase 1, the agencies are proposing to continue to provide two paths for approval of the test procedure to measure the CO_2 emissions and fuel consumption reductions of an off-cycle technology used in the HD tractor. See proposed 40 CFR 1037.610 and 49 CFR 535.7. The first path would not require a public approval process of the test method. A manufacturer could use ''pre-approved'' test methods for HD vehicles including the A-to-B chassis testing, powerpack testing or on-road testing. A manufacturer may also use any developed test procedure that has known quantifiable benefits. A test plan detailing the testing methodology would be required to be approved prior to collecting any test data. The agencies are also proposing to continue the second path, which includes a public approval process of any testing method that could have questionable benefits (*i.e.,* an unknown usage rate for a technology). Furthermore, the agencies are proposing to modify their provisions to clarify what documentation must be submitted for approval, which would align them with provisions in 40 CFR 86.1869–12. NHTSA and EPA are also proposing to prohibit credits from technologies addressed by any of NHTSA's crash avoidance safety rulemakings (*i.e.,* congestion management systems). See 77 FR 62733 (discussing similar issues in the context of the light-duty fuel economy and greenhouse gas reduction standards). We welcome recommendations on how to improve or streamline the off-cycle technology approval process.

(3) Post Useful Life Modifications

Under 40 CFR part 1037, it is generally prohibited for any person to remove or render inoperative any emission control device installed to comply with the requirements of part 1037. However, in 40 CFR 1037.655 EPA clarifies that certain vehicle modifications are allowed after a vehicle reaches the end of its regulatory useful life. This section applies for all vehicles subject to 40 CFR part 1037 and would thus apply for trailers regulated in Phase 2. EPA is proposing to continue this provision and requests comment on it.

This section states (as examples) that it is generally allowable to remove tractor roof fairings after the end of the vehicle's useful life if the vehicle will no longer be used primarily to pull box trailers, or to remove other fairings if the vehicle will no longer be used significantly on highways with vehicle speed of 55 miles per hour or higher. More generally, this section clarifies that owners may modify a vehicle for the purpose of reducing emissions, provided they have a reasonable technical basis for knowing that such modification will not increase emissions of any other pollutant. This essentially requires the owner to have information that would lead an engineer or other person familiar with engine and vehicle design and function to reasonably believe that the modifications will not increase emissions of any regulated pollutant. Thus, this provision does not provide a blanket allowance for modifications after the useful life.

This section also makes clear that no person may ever disable a vehicle speed limiter prior to its expiration point, or remove aerodynamic fairings from tractors that are used primarily to pull box trailers on highways. It is also clear that this allowance does not apply with respect to engine modifications or recalibrations.

This section does not apply with respect to modifications that occur within the useful life period, other than to note that many such modifications to the vehicle during the useful life and to the engine at any time are presumed to violate 42 U.S.C. 7522(a)(3)(A). EPA notes, however, that this is merely a presumption, and would not prohibit modifications during the useful life where the owner clearly has a reasonable technical basis for knowing that the modifications would not cause the vehicle to exceed any applicable standard.

(4) Other Interim Provisions

In HD Phase 1, EPA adopted provisions to delay the onboard diagnostics (OBD) requirements for heavy-duty hybrid powertrains (see 40 CFR 86.010–18(q)). This provision delayed full OBD requirements for hybrids until 2016 and 2017 model years. In discussion with manufacturers during the development of Phase 2, the agencies have learned that meeting the on-board diagnostic requirements for criteria pollutant engine certification continues to be a potential impediment to adoption of hybrid systems. See Section XIV.A.1 for a discussion of regulatory changes proposed to reduce the non-GHG certification burden for engines paired with hybrid powertrain systems.

(5) Phase 1 Flexibilities Not Proposed for Phase 2

The Phase 1 advanced technology credits were adopted to promote the implementation of advanced technologies, such as hybrid powertrains, Rankine cycle engines, all-electric vehicles, and fuel cell vehicles (see 40 CFR 1037.150(i)). As the agencies stated in the Phase 1 final rule, the Phase 1 standards were not premised on the use of advanced technologies but we expected these advanced technologies to be an important part of the Phase 2 rulemaking (76 FR 57133, September 15, 2011). The proposed HD Phase 2 heavy-duty engine and tractor standards are premised on the use of Rankine-cycle engines, therefore the agencies believe it is no longer appropriate to provide extra credit for this technology. While the agencies have not premised the proposed HD Phase 2 tractor standards on hybrid powertrains, fuel cells, or electric vehicles, we also foresee some limited use of these technologies in 2021 and beyond. Therefore, we propose to not provide advanced technology credits in Phase 2 for any technology, but we welcome comments on the need for such incentive.

Also in Phase 1, the agencies adopted early credits to create incentives for manufacturers to introduce more efficient engines and vehicles earlier than they otherwise would have planned to do (see 40 CFR 1037.150(a)). The agencies are not proposing to extend this flexibility to Phase 2 because the ABT program from Phase 1 will be available to manufacturers in 2020 model year and this would displace the need for early credits.

IV. Trailers

As mentioned in Section III, trailers pulled by Class 7 and 8 tractors (together considered ''tractor-trailers'') account for approximately two-thirds of the heavy-duty sector's total CO_2 emissions and fuel consumption. Because neither trailers nor the tractors that pull them are useful by themselves, it is the combination of the tractor and the trailer that forms the useful vehicle. Although trailers do not directly generate exhaust emissions or consume fuels (except for the refrigeration units on refrigerated trailers), their designs and operation nevertheless contribute substantially to the CO_2 emissions and diesel fuel consumption of the tractors pulling them. See also Section I.E (1) and (2) above.

The agencies are proposing standards for trailers specifically designed to be drawn by Class 7 and 8 tractors when coupled to the tractor's fifth wheel. The agencies are not proposing standards for trailers designed to be drawn by vehicles other than tractors, and those that are coupled to vehicles with pintle hooks or hitches instead of a fifth wheel. These proposed standards are expressed as CO_2 and fuel consumption standards, and would apply to each trailer with respect to the emissions and fuel consumption that would be expected for a specific standard type of tractor pulling such a trailer. Note that this approach is discussed in more detail later. Nevertheless, EPA and NHTSA believe it is appropriate to establish standards for trailers separately from tractors because they are separately manufactured by distinct companies; the agencies are not aware of any manufacturers that currently assemble both the finished tractor and the trailer.

A. Summary of Trailer Consideration in Phase 1

In the Phase 1 program, the agencies did not regulate trailers, but discussed how we might do so in the future (see 76 FR 57362). We chose not to regulate trailers at that time, primarily because of the lack of a proposed test procedure, as well as the technical and policy issues at that time. The agencies also noted the large number of small businesses in this industry, the possibility that regulations would substantially impact these small businesses, and the agencies' consequent obligations under the Small Business Regulatory Enforcement Fairness Act.[202] However, the agencies did indicate the potential CO_2 and fuel consumption benefits of including trailers in the program and we committed to consider establishing standards for trailers in future rulemakings.

In the Phase 1 proposal, the agencies solicited general comments on controlling CO_2 emissions and fuel consumption through future trailer regulations (see 75 FR 74345–74351). Although we neither proposed nor finalized trailer regulations at that time, the agencies have considered those comments in developing this proposal. This notice proposes the first EPA regulations covering trailer manufacturers for CO_2 emissions (or any other emissions), and the first fuel consumption regulations by NHTSA for these manufacturers. The agencies intend for this program to be a unified national program so that when a trailer model complies with EPA's standards it will also comply with NHTSA's standards.

B. The Trailer Industry

(1) Industry Characterization

The trailer industry encompasses a wide variety of trailer applications and designs. Among these are box trailers (dry vans and refrigerated vans of all sizes) and ''non-box'' trailers, including platform (sometimes called ''flatbed''), tanker, container chassis, bulk, dump, grain, and many specialized types of trailers, such as car carriers, pole trailers, and logging trailers. Most trailers are designed for predominant use on paved streets, roads, and highways (called ''highway trailers'' for purposes of this proposed rule). A relatively small number of trailers are designed for dedicated use in logging and mining operations or for use in

[202] The Regulatory Flexibility Act (RFA), as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA), requires agencies to account for economic impacts of all rules that may have a significant impact on a substantial number of small businesses and in addition contains provisions specially applicable to EPA requiring a multi-agency pre-proposal process involving outreach and consultation with representatives of potentially affected small businesses. See *http://www.epa.gov/rfa/* for more information. Note that for this Phase 2 proposal, EPA has completed a Small Business Advocacy Review panel process that included small trailer manufacturers, as discussed in XIV.C below.

applications that we expect would involve little or no time on paved roadways. A more detailed description of the characteristics that distinguish these trailers is included in Section IV.C.(5).

The trailer manufacturing industry is very competitive, and manufacturers are highly responsive to their customers' diverse demands. The wide range of trailer designs and features reflects the broad variety of customer needs, chief among them typically being the ability to maximize the amount of freight the trailer can transport. Other design goals reflect the numerous, more specialized customer needs.

Box trailers are the most common type of trailer and are made in many different lengths, generally ranging from 28 feet to 53 feet. While all have a rectangular shape, they can vary widely in basic construction design (internal volume and weight), materials (steel, fiberglass composites, aluminum, and wood) and the number and configuration of axles (usually two axles closely spaced, but number and spacing of axles can be greater). Box trailer designs may also include additional features, such as one or more side doors, out-swinging or roll-up rear doors, side or rear lift gates, and numerous types of undercarriage accessories.

Non-box trailers are uniquely designed to transport a specific type of freight. Platform trailers carry cargo that may not be easily contained within or loaded and unloaded into a box trailer, such as large, nonuniform equipment or machine components. Tank trailers are often pressure-tight enclosures designed to carry liquids, gases or bulk, dry solids and semi-solids. There are also a number of other specialized trailers such as grain, dump, automobile hauler, livestock trailers, construction and heavy-hauling trailers.

Chapter 1 of the Draft RIA includes a more thorough characterization of the trailer industry. The agencies have considered the variety of trailer designs and applications in developing the proposed CO_2 emissions and fuel consumption standards for trailers.

(2) Historical Context for Proposed Trailer Provisions

(a) SmartWay Program

EPA's voluntary SmartWay Transport Partnership program encourages businesses to take actions that reduce fuel consumption and CO_2 emissions while cutting costs. See Section I.A.2.f above. SmartWay staff work with the shipping, logistics, and carrier communities to identify low carbon strategies and technologies across their transportation supply chains. It is a voluntary, fleet-targeted program that provides an objective ranking of a fleet's freight efficiency relative to its competitors. SmartWay Partners commit to adopting fuel-saving practices and technologies relative to a baseline year as well as tracking their progress.

EPA's SmartWay program has accelerated the availability and market penetration of advanced, fuel efficient technologies and operational practices. In conjunction with the SmartWay Partners Program, EPA established a testing, verification, and designation program, the SmartWay Technology Program, to help freight companies identify the equipment, technologies, and strategies that save fuel and lower emissions. SmartWay verifies the performance of aerodynamic equipment and low rolling resistance tires and maintains a list of verified technologies on its Web site. The trailer aerodynamic technologies verified are grouped in bins that represent one percent, four percent, or five percent fuel savings relative to a typical long-haul tractor-trailer at 65-mph cruise conditions. Historically, use of verified aerodynamic devices totaling at least five percent fuel savings, along with verified tires, qualifies a 53-foot dry van trailer for the ''SmartWay Trailer'' designation. In 2014, EPA expanded the program to qualify trailers as ''SmartWay Elite'' if they use verified tires and aerodynamic equipment providing nine percent or greater fuel savings. The 2014 updates also expanded the SmartWay-designated trailer eligibility to include 53-foot refrigerated van trailers in addition to 53-foot dry van trailers.

The SmartWay Technology Program continues to improve the technical quality of data that EPA and stakeholders need for verification. EPA bases its SmartWay verifications on common industry test methods using SmartWay-specified testing protocols. Historically, SmartWay's aerodynamic equipment verification was performed using the SAE J1321 test procedure, which measures fuel consumption as the test vehicle drives laps around a test track. Under SmartWay's 2014 updates, EPA expanded its trailer designation and equipment verification programs to allow additional testing options. The updates included a new, more stringent 2014 track test protocol based on SAE's 2012 update to its SAE J1321 test method,[203] as well as protocols for wind tunnel, coastdown, and possibly computational fluid dynamics (CFD) approaches. These new protocols are based on stakeholder input, the latest industry standards (*i.e.,* 2012 versions of the SAE fuel consumption and wind tunnel test[204] methods), EPA's own testing and research, and lessons learned from years of implementing technology verification programs. Wind tunnel, coastdown, and CFD testing produce values for aerodynamic drag improvements in terms of coefficient of drag (C_D), which is then related to projected fuel savings using a mathematical curve.[205]

SmartWay verifies tires based on test data submitted by tire manufacturers demonstrating the coefficient of rolling resistance (C_{RR}) of their tires using either the SAE J1269 or ISO 28580 test methods. These verified tires have rolling resistance targets for each axle position on the tractor-trailer. SmartWay-verified trailer tires achieve a C_{RR} of 5.1 kg/metric ton or less on the ISO28580 test method. An operator who replaces the trailer tires with SmartWay-verified tires can expect fuel consumption savings of one percent or more at a 65-mph cruise. Operators who apply SmartWay-verified tires on both the trailer *and* tractor can achieve three percent fuel consumption savings at 65-mph.

Over the last decade, SmartWay partners have demonstrated measureable fuel consumption benefits by adding aerodynamic features and low rolling resistance tires to their 53-foot dry van trailers. To date, SmartWay has verified over 70 technologies, including nine packages from five manufacturers that have received the Elite designation. The SmartWay Transport program has worked with over 3,000 partners, the majority of which are trucking fleets, and broadly throughout the supply-chain industry, since 2004. These relationships, combined with the Technology Program's extensive involvement in the HD vehicle technology industry, have provided EPA with significant experience in freight fuel efficiency. Furthermore, the more than 10-year duration of the voluntary SmartWay Transport Partnership has resulted in significant fleet and manufacturer experience with innovating and deploying technologies

[203] SAE International, Fuel Consumption Test Procedure—Type II. SAE Standard J1321. Revised 2012–02–06. Available at: *http://standards.sae.org/j1321_201202/*.

[204] SAE International. Wind Tunnel Test Procedure for Trucks and Buses. SAE Standard J1252. Revised 2012–07–16. Available at: *http://standards.sae.org/j1252_201207/*.

[205] McCallen, R., et al. Progress in Reducing Aerodynamic Drag for Higher Efficiency of Heavy Duty Trucks (Class 7–8). SAE Technical Paper. 1999–01–2238.

that reduce CO_2 emissions and fuel consumption.

(b) California Tractor-Trailer Greenhouse Gas Regulation

The state of California passed the Global Warming Solutions Act of 2006 (Assembly Bill 32, or AB32), enacting the state's 2020 greenhouse gas emissions reduction goal into law. Pursuant to this Act, the California Air Resource Board (CARB) was required to begin developing early actions to reduce GHG emissions. As a part of a larger effort to comply with AB32, the California Air Resource Board issued a regulation entitled ''Heavy-Duty Greenhouse Gas Emission Reduction Regulation'' in December 2008.

This regulation reduces GHG emissions by requiring improvement in the efficiency of heavy-duty tractors and 53 foot or longer dry and refrigerated box trailers that operate in California.[206] The program is being phased in between 2010 and 2020. Small fleets have been allowed special compliance opportunities to phase in the retrofits of their existing trailer fleets through 2017. The regulation requires affected trailer fleet owners to either use SmartWay-verified trailers or to retrofit trailers with SmartWay-verified technologies. The efficiency improvements are achieved through the use of aerodynamic equipment and low rolling resistance tires on both the tractor and trailer. EPA has granted a waiver for this California program.[207]

(c) NHTSA Safety-Related Regulations for Trailers and Tires

NHTSA regulates new trailer safety through regulations. Table IV–1 lists the current regulations in place related to trailers. Trailer manufacturers will continue to be required to meet current safety regulations for the trailers they produce. We welcome any comments on additional regulations that are not included and particularly those that may be incompatible with the regulations outlined in this proposal.

FMVSS Nos. 223 and 224 [208] require installation of rear guard protection on trailers. The definition of rear extremity of the trailer in 223 limits installation of rear fairings to a specified zone behind the trailer. The agencies request comment on any issues associated with installing potential boat tails or other rear aerodynamic fairings that would be more effective than current designs, given the current definition of trailer rear extremity in FMVSS 223.

TABLE IV—1 CURRENT NHTSA STATUTES AND REGULATIONS RELATED TO TRAILERS

Reference	Title
49 CFR 565 ...	Vehicle Identification Number (VIN) Requirements.
49 CFR 566 ...	Manufacturer Identification.
49 CFR 567 ...	Certification.
49 CFR 568 ...	Vehicles Manufactured in Two or More Stages.
49 CFR 569 ...	Regrooved Tires.
49 CFR 571 ...	Federal Motor Vehicle Safety Standards.
49 CFR 573 ...	Defect and Noncompliance Responsibility and Reports.
49 CFR 574 ...	Tire Identification and Recordkeeping.
49 CFR 575 ...	Consumer Information.
49 CFR 576 ...	Record Retention.

(d) Additional DOT Regulations Related to Trailers

In addition to NHTSA's regulations, DOT's Federal Highway Administration (FHWA) regulates the weight and dimensions of motor vehicles on the National Network.[209] FHWA's regulations limit states from setting truck size and weight limits beyond certain ranges for vehicles used on the National Network. Specifically, vehicle weight and truck tractor-semitrailer length and width are limited by FHWA.[210] EPA and NHTSA do not anticipate any conflicts between FHWA's regulations and those proposed in this rulemaking.

(3) Agencies' Outreach in Developing This Proposal

In developing this proposed rule, EPA and NHTSA staff met and consulted with a wide range of organizations that have an interest in trailer regulations. Staff from both agencies met representatives of the Truck Trailer Manufacturers Association, the National Trailer Dealers Association, and the American Trucking Association, including their Fuel Efficiency Advisory Committee and their Technology and Maintenance Council. We also met with and visited the facilities of several individual trailer manufacturers, trailer aerodynamic device manufacturing companies, and trailer tire manufacturers, as well as visited an aerodynamic wind tunnel test facility and two independent tire testing facilities. The agencies consulted with representatives from California Air Resources Board, the International Council on Clean Transportation, the North American Council for Freight Efficiency, and several environmental NGOs.

In addition to these informal meetings, and as noted above, EPA also conducted several outreach meetings with representatives from small business trailer manufacturers as required under section 609(b) of the Regulatory Flexibility Act (RFA) and amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA). EPA convened a Small Business Advocacy Review (SBAR) Panel, and additional information regarding the findings and recommendations of the Panel are available in Section XIV below and in the Panel's final report.[211] EPA worked with NHTSA to propose flexibilities in response to EPA's SBAR Panel (as outlined in Section IV. F(6)(f) with more detail provided in Chapter 12 of the draft RIA). We welcome comments from all entities and the public to all aspects of this proposal.

C. Proposed Phase 2 Trailer Standards

This proposed rule proposes, for the first time, a set of CO_2 emission and fuel consumption standards for manufacturers of new trailers that would phase in over a period of nine years and continue to reduce CO_2 emissions and fuel consumption in the years to follow. The proposed standards are expressed as overall CO_2 emissions and fuel consumption performance standards considering the trailer as an integral part of the tractor-trailer vehicle.

The agencies are proposing trailer standards that we believe well implement our respective statutory obligations. The agencies believe that a proposed set of standards with similar stringencies, but less lead-time (referred to as ''Alternative 4'' and discussed in more detail later) has the potential to be the maximum feasible alternative within the meaning of section 32902 (k) of EISA, and appropriate under EPA's CAA authority (sections 202 (a)(1) and (2)). However, based on the evidence

[206] Recently, in December 2013, ARB adopted regulations that establish its own parallel Phase 1 program with standards consistent with the EPA Phase 1 tractor standards. On December 5, 2014 California's Office of Administrative Law approved ARB's adoption of the Phase 1 standards, with an effective date of December 5, 2014.

[207] See EPA's waiver of CARB's heavy-duty tractor-trailer greenhouse gas regulation applicable to new 2011 through 2013 model year Class 8 tractors equipped with integrated sleeper berths (sleeper-cab tractors) and 2011 and subsequent model year dry-can and refrigerated-van trailers that are pulled by such tractors on California highways at 79 FR 46256 (August 7, 2014).

[208] 49 CFR 571.223, 224.

[209] 23 CFR 658.9.

[210] 23 CFR part 658.

[211] Final Report of the Small Business Advocacy Review Panel on EPA's Planned Proposed Rule: Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles: Phase 2, January 15, 2015.

currently before us, EPA and NHTSA have outstanding questions regarding relative risks and benefits of Alternative 4 due to the timeframe envisioned by that alternative. The proposed alternative (referred to as ''Alternative 3'' and discussed in more detail later) is generally designed to achieve the levels of fuel consumption and GHG reduction that Alternative 4 would achieve, but with several years of additional lead-time. Put another way, the Alternative 3 standards would result in the same stringency as the Alternative 4 standards, but several years later, meaning that manufacturers could, in theory apply new technology at a more gradual pace and with greater flexibility. Additional lead-time will also provide for a more gradual implementation of full compliance program, which could be especially helpful for this newly-regulated trailer industry. It is possible that the agencies could adopt, in full or in part, stringencies from Alternative 4 in the final rule. The agencies seek comment on the lead-time and market penetration in these alternatives.

The agencies are not proposing standards for CO_2 emissions and fuel consumption from the transport refrigeration units (TRUs) used on refrigerated box trailers. Additionally, EPA is not proposing standards for hydrofluorocarbon (HFC) emissions from TRUs. See Section IV.C.(4)

It is worth noting that the proposed standards for box trailers are based in part on the expectation that the proposed program would allow emissions averaging. However, as discussed in Section IV.F. below, given the specific structure and competitive nature of the trailer industry, we request comment on the advantages and disadvantages of implementing the proposed standards without an averaging program. Commenters addressing the stringency of the proposed standards are encouraged to address stringency in the context of compliance programs with and without averaging.

(1) Trailer Designs Covered by This Proposed Rule

As described previously, the trailer industry produces many different trailer designs for many different applications. The agencies are proposing standards for a majority of these trailers. Note that these proposed regulations apply to trailers designed for being drawn by a tractor when coupled to the tractor's fifth wheel. As described in detail in Section IV.C below, the agencies are proposing standards that would phase in between MY 2018 and 2027; the NHTSA standards would be voluntary until MY 2021. The proposed standards would apply to most types of trailers. For most box trailers, these standards would be based on the use of various technologies to improve aerodynamic performance, and on improved tire efficiency through low rolling resistance tires and use of automatic tire inflation (ATI) systems. As discussed below, the agencies have identified some trailers with characteristics that limit the aerodynamics that can be applied, and are proposing reduced the stringencies for those trailer types. As described in Sections IV.D.(1)(d) and (2)(d) below, although manufacturers can reduce trailer weight to reduce fuel costs by reducing trailer weight, these standards are not predicated on weight reduction for the industry.

The most comprehensive set of proposed requirements would apply to long box trailers, which include refrigerated and non-refrigerated (dry) vans. Long box trailers are the largest trailer category and are typically paired with high roof cab tractors that have high annual vehicle miles traveled (VMT) and high average speeds, and therefore offer the greatest potential for CO_2 and fuel consumption reductions. Many of the aerodynamic and tire technologies considered for long box trailers in this proposal are similar to those used in EPA's SmartWay program and required by California's Heavy-Duty Greenhouse Gas Emission Reduction Regulation. Many manufacturers and operators of box trailers have experience with these CO_2- and fuel consumption-reducing technologies. In addition to SmartWay partners and those fleets affected by the California regulation, many operators also seek such technologies in response to high fuel prices and the prospect of improved fuel efficiency. As a result, more data about the performance of these technologies exist for long box trailers than for other trailer types. Short box vans do not have the benefit of programs such as SmartWay to provide an incentive for development of and a reliable evaluation and promotion of CO_2- and fuel consumption-reducing technologies for their trailers. In addition, short box trailers are more frequently used in short-haul and urban operations, which may limit the potential effectiveness of these technologies. As such, EPA is proposing less stringent requirements for manufacturers of short box trailers.

Some trailer designs include features that can affect the practicality or the effectiveness of devices that manufacturers may consider to lower their CO_2 emissions and fuel consumption. We are proposing to recognize box trailers that are restricted from using aerodynamic devices in one location on the trailer as ''partial-aero'' box trailers.[212] The proposed standards for these trailers are based on the proposed standards for full-aero box-trailers, but would be less stringent than when the program is fully phased in.

We propose that box trailers that have work-performing devices in two locations such that they inhibit the use of *all* practical aerodynamic devices be considered ''non-aero'' box trailers in this proposal. The proposed standards for non-aero box trailers are predicated on the use of tire technologies—lower rolling resistance tires and ATI. We are proposing similar standards for non-box trailers (including applications such as dump trailers and agricultural trailers that are designed to be used both on and off the highway).

We are proposing to completely exclude several types of trailers from this trailer program. These excluded trailers would include those designed for dedicated in-field operations related to logging and mining. In addition, we are proposing to exclude heavy-haul trailers and trailers the primary function of which is performed while they are stationary. For all of these excluded trailers, manufacturers would not have any regulatory requirements under this program, and would not be subject to the proposed trailer compliance requirements. We seek comment on the appropriateness of excluding these types of trailers from the proposed trailer program and whether other trailer designs should be excluded. Section IV. C. (5) discusses these trailer types we propose to exclude and the physical characteristics that would define these trailers.

In summary, the agencies are proposing separate standards for ten trailer subcategories:

—Long box (longer than 50 feet[213]) dry vans
—Long box (longer than 50 feet) refrigerated vans
—Short box (50 feet and shorter) dry vans
—Short box (50 feet and shorter) refrigerated vans
—Partial-aero long box dry vans
—Partial-aero long box refrigerated vans
—Partial-aero short box dry vans

[212] Examples of types of work-performing components, equipment, or designs that the agencies might consider as warranting recognition as partial-aero or non-aero trailers include side or end lift gates, belly boxes, pull-out platforms or steps for side door access, and drop-deck designs. See 40 CFR 1037.107 and 49 CFR 535.5(e).

[213] Most long trailers are 53 feet in length; we are proposing a cut-point of 50 feet to avoid an unintended incentive for an OEM to slightly shorten a trailer design in order to avoid the new regulatory requirements.

—Partial-aero short box refrigerated vans
—Non-aero box vans (all lengths of dry and refrigerated vans)
—Non-box trailers (tanker, platform, container chassis, and all other types of highway trailers that are not box trailers)

As discussed in the next section, partial-aero box trailers would have the same standards as their corresponding full-aero trailers in the early phase-in years, and would have separate, less stringent standards as the program is fully implemented. Section IV. C. (5) introduces these proposed partial-aero trailer standards and Section IV. D. describes the technologies that could be applied to meet these proposed standards.

(2) Proposed Fuel Consumption and CO_2 Standards

As described in previously, it is the combination of the tractor and the trailer that form the useful vehicle, and trailer designs substantially affect the CO_2 emissions and diesel fuel consumption of the tractors pulling them. Note that although the agencies are proposing new CO_2 and fuel consumption standards for trailers separately from tractors, we set the numerical level of the trailer standards (see Section IV.D below) in relation to ''standard'' reference tractors in recognition of their interrelatedness. In other words, the regulatory standards refer to the simulated emissions and fuel consumption of a standard tractor pulling the trailer being certified.

The agencies project that these proposed standards, when fully implemented in MY (model year) 2027, would achieve fuel consumption and CO_2 emissions reductions of three to eight percent, depending on trailer subcategory. These projected reductions assume a degree of technology adoption into the future absent the proposed program and are evaluated on a weighted drive cycle (see Section IV. D. (3) . We expect that the MY 2027 standards would be met with high-performing aerodynamic and tire technologies largely available in the marketplace today. With a lead-time of more than 10 years, the agencies believe that both trailer construction and bolt-on CO_2- and fuel consumption-reducing technologies will advance well beyond the performance of their current counterparts that exist today. A description of technologies that the agencies considered for this proposal is provided in Section IV. D.

The agencies designed this proposed trailer program to ensure a gradual progression of both stringency and compliance requirements in order to limit the impact on this newly-regulated industry. The agencies are proposing progressively more stringent standards in three-year stages leading up to the MY 2027.[214] The agencies are proposing several options to reduce compliance burden (see Section IV. F.) in the early years as the industry gains experience with the program. EPA is proposing to initiate its program in 2018 with modest standards for long box dry and refrigerated vans that can be met with common SmartWay-verified aerodynamic and tire technologies. In this early stage, we expect that manufacturers of the other trailer subcategories would meet those standards by using tire technologies only. Standards that we propose for the next stages, which we propose to begin in MY 2021, MY 2024, and MY 2027, would gradually increase in stringency for each subcategory, including the introduction of standards for shorter box vans that we expect would be met by applying both aerodynamic and tire technologies. NHTSA's regulations would be voluntary until MY 2021 as described in Section IV. C. (3).

Table IV–2 below presents the CO_2 and fuel consumption phase-in standards, beginning in MY 2018 that the agencies are proposing for trailers. The standards are expressed in grams of CO_2 per ton-mile and gallons of fuel per 1,000 ton-miles to reflect the load-carrying capacity of the trailers. Partial-aero trailers would be subject to the same standards as their corresponding ''full aero'' trailers for MY 2018 through MY 2026. In MY 2027 and the years to follow, partial-aero trailers would continue to meet the standards for MY 2024.

The agencies are not proposing CO_2 or fuel consumption standards predicated on aerodynamic improvements for non-box trailers or non-aero box vans at any stage of this proposed program. Instead, we are proposing design standards that would require manufacturers of these trailers to adopt specific tire technologies and thus to comply without aerodynamic devices. We believe that this approach would significantly limit the compliance burden for these manufacturers and request comment on this provision.[215]

TABLE IV–2—PROPOSED TRAILER CO_2 AND FUEL CONSUMPTION STANDARDS FOR BOX TRAILERS

Model year	Subcategory	Dry van		Refrigerated van	
	Length	Long	Short	Long	Short
2018–2020	EPA Standard (CO_2 Grams per Ton-Mile).	83	144	84	147
	Voluntary NHTSA Standard (Gallons per 1,000 Ton-Mile).	8.1532	14.1454	8.2515	14.4401
2021–2023	EPA Standard (CO_2 Grams per Ton-Mile).	81	142	82	146
	NHTSA Standard (Gallons per 1,000 Ton-Mile).	7.9568	13.9489	8.0550	14.3418
2024–2026	EPA Standard (CO_2 Grams per Ton-Mile).	79	141	81	144
	NHTSA Standard (Gallons per 1,000 Ton-Mile).	7.7603	13.8507	7.9568	14.1454
2027 +	EPA Standard (CO_2 Grams per Ton-Mile).	77	140	80	144
	NHTSA Standard (Gallons per 1,000 Ton-Mile).	7.5639	13.7525	7.8585	14.1454

[214] These stages are consistent with NHTSA's stability requirements under EISA.

[215] The agencies are not proposing provisions to allow averaging for non-box trailers, non-aero box trailers, or partial-aero box trailers, and this reduced flexibility would likely have the effect of requiring compliant tire technologies to be used.

Differences in the numerical values of these standards among trailer subcategories are due to differences in the tractor-trailer characteristics, as well as differences in the default payloads, in the vehicle simulation model we used to develop the proposed standards (as described in Section IV. D. (3) (a) below). Lower numerical values in Table IV–2 do not necessarily indicate more stringent standards. For instance, the proposed standards for dry and refrigerated vans of the same length have the same stringency through MY 2026, but the standards recognize differences in trailer weight and aerodynamic performance due to the TRU on refrigerated vans. Trailers of the same type but different length differ in weight as well as in the number of axles (and tires), tractor type, payload and aerodynamic performance. Section IV. D. and Chapter 2.10 of the draft RIA provide more details on the characteristics of the tractor-trailer vehicles, with various technologies, that are the basis for these standards.

In developing the proposed standards for trailers, the agencies evaluated the current level of CO_2 emissions and fuel consumption, the types and availability of technologies that could be applied to reduce CO_2 and fuel consumption, and the current adoption rates of these technologies. Additionally, we considered the necessary lead-time and associated costs to the industry to meet these standards, as well as the fuel savings to the consumer and magnitude of CO_2 and fuel savings that we project would be achieved as a result of these proposed standards. As discussed in more detail later in this preamble and in Chapter 2.10 of the draft RIA, the analyses of trailer aerodynamic and tire technologies that the agencies have conducted appear to show that these proposed standards would be the maximum feasible and appropriate in the lead-time provided under each agency's respective statutory authorities. We ask that any comments related to stringency include data whenever possible indicating the potential effectiveness and cost of adding such devices to these vehicles.

The agencies request comment on all aspects of these proposed standards, including trailers to be covered and the proposed 50-foot demarcation between ''long'' and ''short'' box vans, the proposed phase-in schedule, and the stringency of the standards in relation to their cost, CO_2 and fuel consumption reductions, and on the proposed compliance provisions, as discussed in Section IV. F.

In addition to these proposed trailer standards, the agencies considered standards both less stringent and more stringent than the proposed standards. We specifically request comment on a set of accelerated standards that we considered, as presented in Section IV. E. This set of standards is predicated on performance and penetration rates of the same technologies as the proposed standards, but would reach full implementation three years sooner.

(3) Lead-Time Considerations

As mentioned earlier, although the agencies did not include standards for trailers in Phase 1, box trailer manufacturers have been gaining experience with CO_2- and fuel consumption-reducing technologies over the past several years, and the agencies expect that trend to continue, due in part to EPA's SmartWay program and California's Tractor-Trailer Greenhouse Gas Regulation. Most manufacturers of long box trailers have some experience installing these aerodynamic and tire technologies for customers. This experience impacts how much lead-time is necessary from a technological perspective. EPA is proposing CO_2 emission standards for long box trailers for MY 2018 that represent stringency levels similar to those used for SmartWay verification and required for the California regulation, and thus could be met by adopting off-the-shelf aerodynamic and tire technologies available today. The NHTSA program from 2018 through 2020 would be voluntary.

Manufacturers of trailers other than 53-foot box vans do not have the benefit of programs such as SmartWay to provide a reliable evaluation and promotion of these technologies for their trailers and therefore have less experience with these technologies. As such, EPA is proposing less stringent requirements for manufacturers of other highway trailer subcategories beginning in MY 2018. We expect these manufacturers of short box trailers would adopt some aerodynamic and tire technologies, and manufacturers of other trailers would adopt tire technologies only, as a means of achieving the proposed standards. Some manufacturers of trailers other than long boxes may not yet have direct experience with these technologies, but the technologies they would need are fairly simple and can be incorporated into trailer production lines without significant process changes. Also, the NHTSA program for these trailers would be voluntary until MY 2021.

The agencies believe that the burdens of installing and marketing these technologies would not be limiting factors in determining necessary lead-time for manufacturers of these trailers. Instead, we expect that the proposed first-time compliance and, in some cases, performance testing requirements, would be the more challenging obstacles for this newly regulated industry. For these reasons, we are proposing that these standards phase in over a period of nine years, with flexibilities that would minimize the compliance and testing burdens in the early years of the proposed program (see Section IV. F.).

As mentioned previously, EPA is proposing modest standards and several compliance options that would allow it to begin its program for MY 2018. However, EISA requires four model years of lead-time for fuel consumption standards, regardless of the stringency level or availability of flexibilities. Therefore, NHTSA's proposed fuel consumption requirements would not become mandatory until MY 2021. Prior to MY 2021, trailer manufacturers could voluntarily participate in NHTSA's program, noting that once they made such a choice, they would need to stay in the program for all succeeding model years.[216]

The agencies believe that the expected period of seven years or more between the issuing of the final rules and full implementation of the program would provide sufficient lead-time for all affected trailer manufacturers to adopt CO_2- and fuel consumption-reducing technologies or design trailers to meet the proposed standards.

(4) Non-CO_2 GHG Emissions from Trailers

In addition to the impact of trailer design on the CO_2 emissions of tractor-trailer vehicles, the agencies recognize that refrigerated trailers can also be a source of emissions of HFCs. Specifically, HFC refrigerants that are used in transport refrigeration units (TRUs) have the potential to leak into the atmosphere. We do not currently believe that HFC leakage is likely to become a major problem in the near future, and we are not proposing provisions addressing refrigerant leakage of trailer-related HFCs in this proposed rulemaking. TRUs differ from the other source categories where EPA has adopted (or proposed) to apply HFC leakage requirements (*i.e.,* air conditioning). We believe trailer owners have a strong incentive to limit refrigerant leakage in order to maintain the operability of the trailer's refrigeration unit and avoid financial liability for damage to perishable freight due to a failure to maintain the agreed-

[216] NHTSA adopted a similar voluntary approach in the first years of Phase 1 (see 76 FR 57106).

upon temperature and humidity conditions. In addition, refrigerated van units represent a relatively small fraction of new trailers. Nevertheless, we request comment on this issue, including any data on typical TRU charge capacity, the frequency of HFC refrigerant leakage from these units across the fleet, the magnitude of unaddressed leakage from individual units, and how potential EPA regulations might address this leakage issue.

(5) Exclusions and Less-Stringent Standards

All trailers built before January 1, 2018 are excluded from the Phase 2 trailer program, and from 40 CFR part 1037 and 49 CFR part 535 in general (see 40 CFR 1037.5(g) and 49 CFR 535.3(e)). Furthermore, the proposed regulations do not apply to trailers designed to be drawn by vehicles other than tractors, and those that are coupled to vehicles with pintle hooks or hitches instead of a fifth wheel. As stated previously, we are proposing that non-box trailers that are designed for dedicated use with in-field operations related to logging and mining be completely excluded from this Phase 2 trailer program. The agencies believe that the operational capabilities of trailers designed for these purposes could be compromised by the use of aerodynamic devices or tires with lower rolling resistance. Additionally, the agencies are proposing to exclude trailers designed for heavy-haul applications and those that are not intended for highway use, as follows:

—Trailers shorter than 35 feet in length with three axles, and all trailers with four or more axles (including any lift axles)
—Trailers designed to operate at low speeds such that they are unsuitable for normal highway operation
—Trailers designed to perform their primary function while stationary
—Trailers intended for temporary or permanent residence, office space, or other work space, such as campers, mobile homes, and carnival trailers
—Trailers designed to transport livestock
—Incomplete trailers that are sold to a secondary manufacturer for modification to serve a purpose other than transporting freight, such as for offices or storage [217]

Where the criteria for exclusion identified above may be unclear for specific trailer models, manufacturers would be encouraged to ask the agencies to make a determination before production begins. The agencies seek comments on these and any other trailer characteristics that might make the trailers incompatible with highway use or would restrict their typical operating speeds.

Because the agencies are proposing that these trailers be excluded from the program, we are not proposing to require manufacturers to report to the agencies about these excluded trailers. We seek comments on whether, in lieu of the exclusion of trailers from the program, the agencies should instead exempt these trailers from the standards, but still require reporting to the agencies in order to verify that a manufacturer qualifies for an exemption. In that case, exempt trailers would have some regulatory requirements (*e.g.,* reporting); again, excluded trailers would have no regulatory requirements under this proposal. All other trailers would remain covered by the proposed standards.

As described earlier, the proposed program is based on the expectation that manufacturers would be able to apply aerodynamic devices and tire technologies to the vast majority of box trailers, and these standards would be relatively stringent. We propose to categorize trailers with functional components or work-performing equipment, and trailers with certain design elements, that could partially interfere with the installation or the effectiveness of some aerodynamic technologies, as ''partial-aero'' box trailers. For example, some trailer equipment by their placement or their need for operator access might not be compatible with current designs of trailer skirts, but a boat tail could be effective on that trailer in the early years of the program. Similarly, a rear lift gate or roll-up rear door might not be compatible with a current boat tail design, but skirts could be effective. The proposed requirements for these trailers would the same as their full-aero counterparts until MY 2027, at which time they would continue to be subject to the MY 2024 standards. See 40 CFR 1037.107.

For trailers for which no aerodynamic devices are practical, the agencies are proposing design standards requiring LRR tires and ATI systems. Trailers for which neither skirt/under-body devices nor rear-end devices would be likely to be feasible fall into two categories: non-box trailers and non-aero box trailers. We believe that there is limited availability of aerodynamic technologies for non-box trailers (for example, platform (flatbed) trailers, tank trailers, and container chassis trailers). Also, for container chassis trailers, operational considerations, such as stacking of the chassis trailers, impede introduction of aerodynamic technologies. In addition, manufacturers of these trailer types have little or no experience with aerodynamic technologies designed for their products. Non-aero box trailers, defined as those with equipment or design features that would preclude both skirt/under-body *and* rear-end aerodynamic technologies (*e.g.,* a trailer with both a pull-out platform for side access and a rear lift gate), would be subject to the same tire-only design standards as would non-box trailers, based exclusively on the performance of tire and ATI technologies.[218]

We recognize that the shortest short box vans (*i.e.,* less than 35 feet) are often pulled in tandem. Since these trailers make up the majority of trailers in the short box van subcategories, we are not proposing standards for short box dry and refrigerated vans based on the use of rear devices. Thus, work-performing features on the rear of the trailer (*e.g.,* lift gates) would not impact a trailer's ability to meet the full-aero short-box trailer standards. As a result, we are proposing that all short box vans only be categorized as partial-aero vans if they have work-performing *side* features (*e.g.,* belly boxes). We expect that partial-aero short *dry* van trailers would be able to adopt front-side devices that would achieve the reduced standards. Furthermore, some short box trailers that are not operated in tandem, such as 40- or 48-foot trailers, could also be able to adopt rear-side devices and achieve even greater reductions.

Refrigerated short box vans are a special case in that they have TRUs that limit the ability to apply aerodynamic technologies to the front side of the trailers. Because of this, we are proposing to classify the shortest refrigerated box vans (shorter than 35 feet) as non-aero trailers if they are designed with work-performing side features. Since these trailers may be pulled in tandem and since they cannot adopt front-side aerodynamic devices, we propose that they meet standards predicated on tire technologies only. Short box refrigerated trailers 35 feet and longer would only qualify for non-aero standards if they have work-

[217] Secondary manufacturers who purchase incomplete trailers and complete their construction to serve as trailers are subject to the requirements of 40 CFR 1037.620.

[218] The agencies are not aware of work-performing equipment that would prevent the use of gap-reducing trailer devices on dry vans of any length; thus dry vans with side and rear equipment could qualify as ''non-aero'' trailers, even if the manufacturer could install a gap-reducing device.

performing devices on both the side *and* rear of the trailer. See 40 CFR 1037.107.

We request comment on these proposed provisions for excluding some trailers from the program, including speed restrictions and physical characteristics that would generally make them incompatible for highway use. We also request comment on the proposed approach of applying less-stringent standards to non-box, non-aero box, and partial-aero box trailers.

(6) In-Use Standards

Consistent with Section 202(a)(1) of the CAA, EPA is proposing that the emissions standards apply for the useful life of the trailers. NHTSA also proposes to adopt EPA's useful life requirements for trailers to ensure manufacturers consider in the design process the need for fuel efficiency standards to apply for the same duration and mileage as EPA standards. Aerodynamic devices available today, including trailer skirts, rear fairings, under-body devices, and gap-reducing fairings, are designed to maintain their physical integrity for the life of the trailer. In the absence of failures like detachment, breakage, or misalignment, we expect that the aerodynamic performance of the devices will not degrade appreciably over time and that the projected CO_2 and fuel consumption reductions will continue for the life of the vehicle with no special maintenance requirements. Because of this, EPA does not see a benefit to establishing separate standards that would apply in-use for trailers. EPA and NHTSA are proposing a regulatory useful life value for trailers of 10 years, and thus the certification standards would apply in-use for that period of time.[219] See Section IV. F. (5) (a) for a discussion of other factors related to trailer useful life.

D. Feasibility of the Proposed Trailer Standards

As discussed below, the agencies' initial determination, subject to consideration of public comment, is that the standards presented in the Section IV.C.2, are the maximum feasible and appropriate under the agencies' respective authorities, considering lead time, cost, and other factors. We summarize our analyses in this section, and describe them in more detail in the Draft RIA (Chapter 2.10).

Our analysis of the feasibility of the proposed CO_2 and fuel consumption standards is based on technology cost and effectiveness values collected from several sources. Our assessment of the proposed trailer program is based on information from:

—Southwest Research Institute evaluation of heavy-duty vehicle fuel efficiency and costs for NHTSA,[220]
—2010 National Academy of Sciences report of Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,[221]
—TIAX's assessment of technologies to support the NAS panel report,[222]
—The analysis conducted by the Northeast States Center for a Clean Air Future, International Council on Clean Transportation, Southwest Research Institute and TIAX for reducing fuel consumption of heavy-duty long haul combination tractors (the NESCCAF/ICCT study),[223]
—The technology cost analysis conducted by ICF for EPA,[224] and
—Testing conducted by EPA.

As an initial step in our analysis, we identified the extent to which fuel consumption- and CO_2-reducing technologies are in use today.

The technologies include those that reduce aerodynamic drag at the front, back, and underside of trailers, tires with lower rolling resistance, tire inflation technologies, and weight reduction through component substitution. It should be noted that the agencies need not and did not attempt to predict the exact future pathway of the industry's response to the new standards, but rather demonstrated one example of how compliance could reasonably occur, taking into account cost of the standards (including costs of compliance testing and certification), and needed lead time. We are proposing that full-aero box trailer manufacturers have additional flexibility in meeting the standards through averaging. The less complex standards proposed for partial- and non-aero box and non-box trailers would still provide a degree of technology choices that would meet their standards.

For our feasibility analysis, we identified a set of technologies to represent the range of those likely to be used in the time frame of the rule. We then combined these technologies into packages of increasing effectiveness in reducing CO_2 and fuel consumption and projected reasonable rates at which the evaluated technologies and packages could be adopted across the trailer industry. More details regarding our analysis can be found in Chapter 2.10.4.1 of the draft RIA.

The agencies developed the proposed CO_2 and fuel consumption standards for each stage of the program by combining the projected effectiveness of trailer technologies and the projected adoption rates for each trailer type. We evaluated these standards with respect to the cost of these technologies, the emission reductions and fuel consumption improvements achieved, and the lead-time needed to deploy the technology at a given adoption rate.

Unlike the other sectors covered by this Phase 2 rulemaking, trailer manufacturers do not have experience certifying under the Phase 1 program. Moreover, a large fraction of the trailer industry is composed of small businesses and very few of the largest trailer manufacturers have the same resources available as manufacturers in the other heavy-duty sectors. The standards have been developed with this in mind, and we are confident the proposed standards can be achieved by manufacturers who lack prior experience implementing such standards.

(1) Available Technologies

Trailer manufacturers can design a trailer to reduce fuel consumption and CO_2 emissions by addressing the trailer's aerodynamic drag, tire rolling resistance and weight. In this section we outline the general trailer technologies that the agencies considered in evaluating the feasibility of the proposed standards.

(a) Aerodynamic Drag Reduction

Historically, the primary goal when designing the shape of box trailers has been to maximize usable internal cargo volume, while complying with regulatory size limits and minimizing construction costs. This led to standard box trailers being rectangular. This basic shape creates significant aerodynamic

[219] EPA may perform in-use testing of any vehicle subject to the standards of this part, including trailers. For example, we may test trailers to verify drag areas or other GEM inputs.

[220] Reinhart, T.E. (June 2015). Commercial Medium- and Heavy-Duty Truck Fuel Efficiency Technology Study—Report #1. (Report No. DOT HS 812 146). Washington, DC: National Highway Traffic Safety Administration.

[221] Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles; National Research Council; Transportation Research Board (2010). Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles. (''The NAS Report'') Washington, DC, The National Academies Press. Available electronically from the National Academy Press Web site at *http://www.nap.edu/catalog.php?record_id=12845*.

[222] TIAX, LLC. ''Assessment of Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles,'' Final Report to National Academy of Sciences, November 19, 2009.

[223] NESCCAF, ICCT, Southwest Research Institute, and TIAX. Reducing Heavy-Duty Long Haul Combination Truck Fuel Consumption and CO_2 Emissions. October 2009.

[224] ICF International. ''Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for Heavy-Duty On-Road Vehicles.'' July 2010. Docket Number EPA–HQ–OAR–2010–0162–0283.

drag and makes box trailers strong candidates for aerodynamic improvements. Current bolt-on aerodynamic technologies for box trailers are designed to create a smooth transition of airflow from the tractor, around the trailer, and beyond the trailer.

Table IV–3 lists general aerodynamic technologies that the EPA SmartWay program has evaluated for use on box trailers and a description of their intended impact. Several versions of each of these technologies are commercially available and have seen increased adoption over the past decade. Performance of these devices varies based on their design, their location and orientation on the trailer, and the vehicle speed. More information regarding the agencies' initial assessment of these devices, including incremental costs is discussed in Chapter 2.10 of the draft RIA.

TABLE IV–3—AERODYNAMIC TECHNOLOGIES FOR BOX TRAILERS

Location on trailer	Example technologies	Intended impact on aerodynamics
Front	Front fairings and gap-reducing fairings	Reduce cross-flow through gap and smoothly transition airflow from tractor to the trailer.
Rear	Rear fairings, boat tails and flow diffusers	Reduce pressure drag induced by the trailer wake.
Underside	Side fairings and skirts, and underbody devices	Manage flow of air under the trailer to reduce turbulence, eddies and wake.

As mentioned previously, SmartWay-verified technologies are evaluated on 53-foot dry vans. However, the CO_2- and fuel consumption-reducing potential of some aerodynamic technologies demonstrated on 53-foot dry vans can be translated to refrigerated vans and box trailers in lengths different than 53 feet and some fleets have opted to add trailer skirts to their refrigerated vans and 28-foot trailers (often called ''pups''). In addition, some side skirts have been adapted for non-box trailers (*e.g.,* tankers, platforms, and container chassis), and have shown potential for large reductions in drag. At this time, however, non-box trailer aerodynamic devices are not widely available, with many still at the prototype stage. The agencies encourage commenters to provide more information and data related to the effectiveness of technologies applied to trailers other than 53-foot dry and refrigerated vans.

''Boat tail'' devices, applied to the rear of a trailer, are typically designed to collapse flat as the trailer rear doors are opened. If the tail structure can remain in the collapsed configuration when the doors are closed, the benefit of the device is lost. The agencies request comment on whether we should require that trailer manufacturers using such devices for compliance with the proposed standards only use designs that automatically deploy when the vehicle is in motion.

The agencies are aware that physical characteristics of some box trailers influence the technologies that can be applied. For instance, the TRUs on refrigerated vans are located at the front of the trailer, which prohibits the use of current gap-reducers. Similarly, drop deck dry vans have lowered floors between the landing gear and the trailer axles that limit the ability to use side skirts. The agencies considered the availability and limitations of aerodynamic technologies for each trailer type evaluated in our feasibility analysis of the proposed and alternative standards.

(b) Tire Rolling Resistance

On a typical Class 8 long-haul tractor-trailer, over 40 percent of the total energy loss from tires is attributed to rolling resistance from the *trailer* tires.[225] Trailer tire rolling resistance values collected by the agencies for Phase 1 indicate that the average coefficient of rolling resistance (C_{RR}) for new trailer tires was 6.0 kg/ton. This value was applied for the standard trailer used for tractor compliance in the Phase 1 tractor program. For Phase 2, the agencies consider all trailer tires with C_{RR} values below 6.0 kg/ton to be ''lower rolling resistance'' (LRR) tires. For reference, a trailer tire that qualifies as a SmartWay-verified tire must meet a C_{RR} value of 5.1 kg/ton, a 15 percent C_{RR} reduction from the trailer tire identified in Phase 1. Our research of rolling resistance indicates an additional C_{RR} reduction of 15 percent or more from the SmartWay verification threshold is possible with tires that are available in the commercial market today.

For this proposal, the agencies are proposing to use the same rolling resistance baseline value of 6.0 kg/ton for all trailer subcategories. We request comment on the appropriateness of 6.0 kg/ton as the proposed C_{RR} threshold for all regulated trailers. Specifically, the agencies would like more information on current adoption rates of and C_{RR} values for models of LRR tires currently in use on short box trailers and the various non-box trailers.

Similar to the case of tractor tires, LRR tires are available as either dual or as single wide-based tires for trailers. Single wide-based tires achieve C_{RR} values that are similar to their dual counterparts, but have an added benefit of weight reduction, which can be an attractive option for trailers that frequently maximize cargo weight. See Section IV.D.1.d below.

(c) Tire Pressure Systems

The inflation pressure of tires also impacts the rolling resistance. Tractor-trailers operating with all tires under-inflated by 10 psi have been shown to increase fuel consumed by up to 1 percent.[226] Tires can gradually lose pressure from small punctures, leaky valves or simply diffusion through the tire casing. Changes in ambient temperature can also have an effect on tire pressure. Trailers that remain unused for long periods of time between hauls may experience any of these conditions. A 2003 FMCSA report found that nearly 1 in 5 trailers had at least 1 tire under-inflated by 20 psi or more. If drivers or fleets are not diligent about checking and attending to under-inflated tires, the trailer may have much higher rolling resistance and much higher CO_2 emissions and fuel consumption.

Tire pressure monitoring (TPM) and automatic tire inflation (ATI) systems are designed to address under-inflated tires. Both systems alert drivers if a tire's pressure drops below its set point. TPM systems are simpler and merely monitor tire pressure. Thus, they require user-interaction to re inflate to the appropriate pressure. Today's ATI systems, on the other hand, typically

[225] ''Tires & Truck Fuel Economy: A New Perspective'', The Tire Topic Magazine, Special Edition Four, 2008, Bridgestone Firestone, North American Tire, LLC. Available online: *http://www.trucktires.com/bridgestone/us_eng/brochures/pdf/08-Tires_and_Truck_Fuel_Economy.pdf.*

[226] ''Tire Pressure Systems—Confidence Report''. North American Council for Freight Efficiency. 2013. Available online: *http://nacfe.org/wp-content/uploads/2014/01/TPS-Detailed-Confidence-Report1.pdf.*

take advantage of trailers' air brake systems to supply air back into the tires (continuously or on demand) until a selected pressure is achieved. In the event of a slow leak, ATI systems have the added benefit of maintaining enough pressure to allow the driver to get to a safe stopping area. The agencies believe TPM systems cannot sufficiently guarantee the proper inflation of tires due to the inherent user-interaction required. Therefore, ATI systems are the only pressure systems the agencies are proposing to recognize in Phase 2.

Benefits of ATI systems in individual trailers vary depending on the base level of maintenance already performed by the driver or fleet, as well as the number of miles the trailer travels. Trailers that are well maintained or that travel fewer miles will experience less benefits from ATI systems compared to trailers that often drive with poorly inflated tires or log many miles. The agencies believe ATI systems can provide a CO_2 and fuel consumption benefit to most trailers. With ATI use, trailers that have lower annual vehicle miles traveled (VMT) due to long periods between uses would be less susceptible to low tire pressures when they resume activity. Trailers with high annual VMT would experience the fuel savings associated with consistent tire pressures. Automatic tire inflation systems could provide a CO_2 and fuel consumption savings of 0.5–2.0 percent, depending on the degree of under-inflation in the trailer system. See Section IV.D.3.d below for discussion of our estimates of these factors, as well as estimates of the degree of adoption of ATI systems prior to and at various points in the phase-in of the proposed program.

The use of ATI systems can result in cost savings beyond reducing fuel costs. For example, drivers and fleets that diligently maintain their tires would spend less time and money to inspect each tire. A 2011 FMCSA estimated under-inflation accounts for one service call per year and increases tire procurement costs 10 to 13 percent. The study found that total operating costs can increase by $600 to $800 per year due to under-inflation.[227]

(d) Weight Reduction

Reduction in trailer tare (*i.e.,* empty) weight can lead to fuel efficiency reductions in two ways. For applications where payload is not limited by weight restrictions, the overall weight of the tractor and trailer would be reduced and would lead to improved fuel efficiency. For applications where payload is limited by weight restrictions, the lower trailer weight would allow additional payload to be transported during the truck's trip, so emissions and fuel consumption on a ton-mile basis would decrease. There are weight reduction opportunities for trailers in both the structural components and in the wheels/tires. Material substitution (*e.g.,* replacing steel with aluminum or lighter-weight composites) is feasible for components such as roof bows, side and corner posts, cross members, floor joists, floors, and van sidewalls. Similar material substitution is feasible for wheels (*e.g.,* substituting aluminum for steel). Weight can also be reduced through the use of single wide-based tires replacing two dual tires.

Lower weight is a desired trailer attribute for many customers, and most trailer manufacturers offer options that reduce weight to some degree. Some of these manufacturers, especially box van makers, market trailers with lower-weight major components, such as light-weight composite van sidewalls or aluminum floors, especially to customers that expect to frequently reach regulatory weight limits (*i.e.,* ''weigh out'') and are willing to pay a premium for the ability to increase cargo weight without exceeding overall vehicle weight. Alternatively, manufacturers that primarily design trailers for customers that do not have weight limit concerns (*i.e.,* their payloads frequently fill the available trailer cargo space before the weight limit is reached, or ''cube out''), or for customers that have smaller budgets, may continue to design trailers based on traditional, heavier materials, such as wood and steel.

There is no clear ''baseline'' for current trailer weight against which lower-weight designs could be compared for regulatory purposes. For this reason, the agencies do not believe it would be appropriate or fair across the industry to apply overall weight reductions toward compliance. However, the agencies do believe it would be appropriate to allow a manufacturer to account for weight reductions that involve substituting very specific, traditionally heavier components with lower-weight options that are not currently widely adopted in the industry. We discuss how we apply weight reduction in developing the standards in Section IV. D. (2)(d) below.

(2) Technological Basis of the Standards

The analysis below presents one possible set of technology designs by which trailer manufacturers could reasonably achieve the goals of the program on average. However, in practice, trailer manufacturers could choose different technologies, versions of technologies, and combinations of technologies that meet the business needs of their customers while complying with this proposed program.

Much of our analysis is performed for box trailers, which have the most stringent proposed standards. As mentioned previously, we have separate standards for short and long box vans, and a trailer length of 50 feet is proposed as the cut-point to distinguish the two length categories. For the purpose of this analysis, long trailers are represented by 53-foot vans and short trailers are represented by single, 28-foot (''pup'') vans. These trailer lengths make up the largest fraction of the vans in the two categories. The agencies recognize that many 28-foot short vans are operated in tandem. However, these trailers are sold individually, and require a ''dolly'', often sold by a separate manufacturer, to connect the trailers for tandem operation.

In addition, the other trailer types considered short vans in this proposal (*e.g.,* 40-foot and 48-foot) typically operate as single trailers. To minimize complexity, we are proposing that 28-foot trailers represent all short refrigerated and dry vans for both compliance and for this feasibility analysis. This means that manufacturers would not need to perform tests (or report device manufacturers' test data) of the performance of devices for each trailer length in the short van category. Although this approach would provide a conservative estimate of actual CO_2 emissions and fuel consumption reductions for the short van category, the agencies believe that the need to avoid an overly complex compliance program justifies this approach. We request comment on this approach to evaluating short box trailers.

(a) Aerodynamic Packages

In order to evaluate performance and cost of the aerodynamic technologies discussed in the previous section, the agencies identified ''packages'' of individual or combined technologies that are being sold today on box trailers. The agencies also identified distinct performance levels (*i.e.,* bins) for these technologies based on EPA's aerodynamic testing. The agencies recognize that there are other technology options that have similar performance. We chose the technologies presented here based on their current adoption rates and effectiveness in reducing CO_2 and fuel consumption.

[227] TMC Future Truck Committee Presentation ''FMCSA Tire Pressure Monitoring Field Operational Test Results,'' February 8, 2011.

Bin I represents a base trailer with no aerodynamic technologies added. There is no cost associated with this bin. Bin II achieves small reductions in CO_2 and fuel consumption. This bin includes a gap reducing fairing added to a long dry van or a skirt added to a solo short dry van.[228] Bin III includes devices that would achieve SmartWay's verification threshold of four percent at cruise speeds. Some basic skirts and boat tails would achieve these levels of reductions for long box trailers. A gap reducer and a basic skirt on a short dry van would meet this level of performance. Bin IV technologies are more effective, single aerodynamic devices for long box trailers, including advanced skirts or boat tails, that achieve larger reductions in drag than the technologies in Bin III. The combination of an advanced skirt and gap reducer on a short dry van are also expected to achieve this bin.

Bin V levels of performance were not observed in EPA's aerodynamic testing for short box trailers. It is possible that a gap reducer, skirt, and boat tail could achieve this performance, but boat tails are not feasible for 28-foot trailers operated in tandem unless the trailer is located in the rear position. For this analysis, the agencies only evaluated solo pup trailers and, therefore, did not evaluate any technologies for short box trailers beyond Bin IV. For this proposed rulemaking, we believe a Bin V level of performance can be achieved for long box trailers by either highly effective single devices or by applying a combination of basic boat tails and skirts. We do not currently have data for a single aerodynamic device that fits this bin and we evaluated it as a combination of a basic tail and skirt. Bin VI combines advanced skirts and boat tail technologies on long box trailers. This bin is expected to include many technologies that qualify for SmartWay's ''Elite'' designation.

Bin VII represents an optimized system of technologies that work together to synergistically address each of the main areas of drag and achieves aerodynamic improvements greater than SmartWay's ''Elite'' designation. We are representing Bin VII with a gap reducer, and advanced tail and skirt. Bin VIII is designed to represent aerodynamic technologies that may become available in the future, including aerodynamic devices yet to be designed or approaches that would incorporate changes to the construction of trailer bodies. We have not analyzed this final bin in terms of effectiveness or cost, but are including it to account for future advancements in trailer aerodynamics.

For this proposal, aerodynamic performance is evaluated using a vehicle's aerodynamic drag area, C_DA. EPA collected aerodynamic test data for several tractor-trailer configurations, including 53-foot dry vans and 28-foot dry van trailers with many of these technology packages. The agencies developed bins, somewhat similar to the aerodynamic bins in the Phase 1 and proposed Phase 2 tractor programs, based on results from our test program. However, unlike the tractor program, we grouped the technologies by changes in C_DA (or ''delta C_DA'') rather than by absolute values. In other words, each bin would comprise aerodynamic technologies that provide similar improvements in drag. This delta C_DA classification methodology, which measures *improvement* in performance relative to a baseline, is similar to the SmartWay technology verification program with which most trailer manufacturers are familiar.

Table IV–4 illustrates the bin structure that the agencies are proposing as the basis for compliance. The table shows example technology packages that might be included in each bin based on EPA's testing of 53-foot dry vans and solo 28-foot dry vans. The agencies believe these bins apply to other box trailers (refrigerated vans and lengths other than 28 and 53 feet), which will be described in more detail in Section IV.D.3.b. These bins cover a wide enough range of delta C_DAs to account for the uncertainty seen in EPA's aerodynamic testing program due to procedure variability, the use of different test methods, or different models of tractors, trailers and devices. A more detailed description of the development of these bins can be found in the draft RIA, Chapter 2.10. We welcome comments and additional data that may support or suggest changes to these bins.

TABLE IV–4—TECHNOLOGY BINS USED TO EVALUATE TRAILER BENEFITS AND COSTS

Bin	Delta C_dA	Average delta C_DA	Example technologies	
			53-foot dry van	28-foot dry van
Bin I	< 0.09	0.0	No Aero Devices	No Aero Devices.
Bin II	0.10–0.19	0.1	Gap Reducer	Skirt.
Bin III	0.20–0.39	0.3	Basic Skirt or Basic Tail	Skirt + Gap Reducer.
Bin IV	0.40–0.59	0.5	Advanced Skirt or Tail	Adv. Skirt + Gap Reducer.
Bin V	0.60–0.79	0.7	Basic Combinations.	
Bin VI	0.80–1.19	1.0	Advanced Combinations (including SmartWay Elite).	
Bin VII	1.20–1.59	1.4	Optimized Combinations.	
Bin VIII	> 1.6	1.8	Changes to Trailer Construction.	

Note: A blank cell indicates a zero or NA value in this table.

The agencies used EPA's Greenhouse gas Emissions Model (GEM) vehicle simulation tool to conduct this analysis. See Section F.1 below for more about GEM. Within GEM, the aerodynamic performance of each trailer subcategory is evaluated by subtracting the delta C_DA shown in Table IV–4 from the C_DA value representing a specific standard tractor pulling a zero-technology trailer. The agencies chose to model the zero-technology long box dry van using a C_DA value of 6.2 m^2 (the average C_DA from EPA's coastdown testing). For long box refrigerated vans, a two percent reduction in C_DA was assumed to account for the aerodynamic benefit of the TRU at the front of the trailer. Short box dry vans also received a two percent lower C_DA value compared to its 53-foot counterpart, consistent with the reduction observed in EPA's wind tunnel testing. The C_DA value assigned to the refrigerated short box vans was an

[228] The agencies recognize that many 28-foot pup trailers are often operated in tandem. However, we are regulating and evaluating short dry vans as solo trailers since they are sold individually and the short box regulatory subcategories also include trailer sizes not often operated in tandem (*e.g.*, 40-foot and 48-foot trailers).

additional two percent lower than the short box dry van. Non-aero box trailers are modeled as short box dry vans. The trailer subcategories that have design standards (*i.e.,* non-box and non-aero box trailers) do not have numerical standards to meet, but they were evaluated in this feasibility analysis in order to quantify the benefits of including them in the program. Non-aero box trailers are modeled as short dry vans. Non-box trailers, which are modeled as flatbed trailers, were assigned a drag area of 4.9 m^2, as was done in the Phase 1 tractor program for low roof day cabs. Table IV–5 illustrates the Bin I drag areas (C_DA) associated with each trailer subcategory.

TABLE IV–5—BASELINE C_DA VALUES ASSOCIATED WITH AERODYNAMIC BIN I

[Zero trailer technologies]

Trailer subcategory	Dry van
Long Dry Van	6.2
Short Dry Van	6.1
Long Ref. Van	6.1
Short Ref. Van	6.0
Non-Aero Box	6.1
Non-Box	4.9

(b) Tire Rolling Resistance

Similar to the proposed Phase 2 tractor and vocational vehicle programs, the agencies are proposing a tire program based on adoption of lower rolling resistance tires. Feedback from several box trailer manufacturers indicates that the standard tires offered on their new trailers are SmartWay-verified tires (*i.e.,* C_{RR} of 5.1 kg/ton or better). An informal survey of members from the Truck Trailer Manufacturers Association (TTMA) indicates about 35 percent of box trailers sold today have SmartWay tires.[229] While some trailers continue to be sold with tires of higher rolling resistances, the agencies believe most box trailer tires currently achieve the Phase 1 trailer tire C_{RR} of 6.0 kg/ton or better.

The agencies evaluated two levels of tire performance for this proposal beyond the baseline trailer tire rolling resistance level (TRRL) of 6.0 kg/ton. The first performance level was set at the criteria for SmartWay-verification for trailer tires, 5.1 kg/ton, which is a 15 percent reduction in C_{RR} from the baseline. As mentioned previously, several tire models available today achieve rolling resistance values well below the present SmartWay threshold. Given the multiple year phase-in of the standards, the agencies expect that tire manufacturers will continue to respond to demand for more efficient tires and will offer increasing numbers of tire models with rolling resistance values significantly better than today's typical LRR tires. In this context, we believe it is reasonable to expect a large fraction of the trailer industry could adopt tires with rolling resistances at a second performance level that would achieve an additional eight percent reduction in rolling resistance (a 22 percent reduction from the baseline tire), especially in the later stages of the program. The agencies project the C_{RR} for this second level of performance to be a value of 4.7 kg/ton.

The agencies evaluated these three tire rolling resistance levels, summarized in Table IV–6, in the feasibility analysis of the following sections. GEM simulations that apply Level 1 and 2 tires result in CO_2 and fuel consumption reductions of two and three percent from the baseline tire, respectively. It should be noted that these levels are for the feasibility analysis only. For compliance, manufacturers would have the option to use tires with any rolling resistance and would not be limited to these TRRLs.

TABLE IV–6—SUMMARY OF TRAILER TIRE ROLLING RESISTANCE LEVELS EVALUATED

Tire rolling resistance level	C_{RR} (kg/ton)
Baseline	6.0
Level 1	5.1
Level 2	4.7

(c) Automatic Tire Inflation Systems

NHTSA and EPA recognize the role of proper tire inflation in maintaining optimum tire rolling resistance during normal trailer operation. For this proposal, rather than require performance testing of ATI systems, the agencies are proposing to recognize the benefits of ATI systems with a single default reduction for manufacturers that incorporate ATI systems into their trailer designs. Based on information available today, we believe that there is a narrow range of performance among technologies available and among systems in typical use. We propose to assign a 1.5 percent reduction in CO_2 and fuel consumption for all trailers that implement ATI systems, based on information available today.[230] We believe the use of these systems can consistently ensure that tire pressure and tire rolling resistance are maintained. We selected the levels of the proposed trailer standards with the expectation that a high rate of adoption of ATI systems would occur across all on-highway trailers and during all years of the phase-in of the program. See Section IV.D.3.d below for discussion of our estimates of these factors, as well as estimates of the degree of adoption of ATI systems prior to and at various points in the phase-in of the proposed program. The informal survey of members from the Truck Trailer Manufacturers Association (TTMA) indicates about 40 percent of box trailers sold today have ATI systems.[231]

(d) Weight Reduction

The agencies are proposing compliance provisions that would limit the weight-reduction options to the substitution of specified components that can be clearly isolated from the trailer as a whole. For this proposal, the agencies have identified several conventional components with available lighter-weight substitutes (*e.g.,* substituting conventional dual tires mounted on steel wheels with wide-based single tires mounted on aluminum wheels). We are proposing values for the associated weight-related savings that would be applied with these substitutions for compliance. The proposed component substitutions and their associated weight savings are presented in the draft RIA, Chapter 2.10.2.4 and in proposed 40 CFR 1037.515. We believe that the initial cost of these component substitutions is currently substantial enough that only a relatively small segment of the industry has adopted these technologies today.

The agencies recognize that when weight reduction is applied to a trailer, some operators will replace that saved weight with additional payload. To account for this in EPA's GEM vehicle simulation tool, it is assumed that one-third of the weight reduction will be applied to the payload. For tractor-trailers simulated in GEM, it takes a weight reduction of nearly 1,000 lbs before a one percent fuel savings is achieved. The component substitutions identified by the agencies result in weight reductions of less than 500 lbs, yet can cost over $1,000. The agencies believe that few trailer manufacturers would apply weight reduction solely as a means of achieving reduced fuel consumption and CO_2 emissions. Therefore, we are proposing standards that could be met without reducing weight—that is, the compliance path set

[229] Truck Trailer Manufacturers Association letter to EPA. Received on October 16, 2014. Docket EPA–HQ–OAR–2014–0827.

[230] See the Chapter 2.10.2.3 of the draft RIA.

[231] Truck Trailer Manufacturers Association letter to EPA. Received on October 16, 2014. Docket EPA–HQ–OAR–2014–0827

out by the agencies for the proposed standards does not include weight reduction. However, we are proposing to offer weight reduction as an option for box trailer manufacturers who wish to apply it to some of their trailers as part of their compliance strategy.

The agencies have identified 11 common trailer components that have lighter weight options available (see 40 CFR 1037.515) [232] [233] [234] [235] Manufacturers that adopt these technologies would sum the associated weight reductions and apply those values in GEM. As mentioned previously, we are restricting the weight reduction options to those listed in 40 CFR 1037.515. We are requesting comment on the appropriateness of the specified weight reductions from component substitution. In addition, we seek weight and cost data regarding additional components that could be offered as specific weight reduction options. The agencies request that any such components be applicable to most box trailers, and that the reduced weight option not currently be in common use.

(3) Effectiveness, Adoption Rates, and Costs of Technologies for the Proposed Standards

The agencies evaluated the technologies above as they apply to each of the trailer subcategories. The next sections describe the effectiveness, adoption rates and costs associated with these technologies. The effectiveness and adoption rates are then used to derive the proposed standards.

(a) Zero-Technology Baseline Tractor-Trailer Vehicles

The regulatory purpose of EPA's heavy-duty vehicle compliance tool, GEM, is to combine the effects of trailer technologies through simulation so that they can be expressed as g/ton-mile and gal/1000 ton-mile and thus avoid the need for direct testing of each trailer model being certified. The proposed trailer program has separate standards for each trailer subcategory, and a unique tractor-trailer vehicle was chosen to represent each subcategory for compliance. In the Phase 2 update to GEM, each trailer subcategory is modeled as a particular trailer being pulled by a standard tractor depending on the physical characteristics and use pattern of the trailer. Table IV–7 highlights the relevant vehicle characteristics for the zero-technology baseline of each subcategory. Baseline trailer tires are used, and the drag area, which is a function of the aerodynamic characteristics of both the tractor and trailer, is set to the Bin I values shown previously in Table IV–5. Weight reduction and ATI systems are not applied in these baselines. Chapter 2.10 of the draft RIA provides a detailed description of the development of these baseline tractor-trailers.

The agencies chose to consistently model a Class 8 tractor across all trailer subcategories. We recognize that Class 7 tractors are sometimes used in certain applications. However, we believe Class 8 tractors are more widely available, which will make it easier for trailer manufacturers to obtain a qualified tractor if they choose to perform trailer testing. We request comment on the use of Class 8 tractors as part of the tractor-trailer vehicles used in the compliance simulation as well as performance testing. We ask that commenters include data, where available, related to the current use and availability of Class 7 and 8 tractors with respect to the trailer types in each trailer subcategory.

TABLE IV—7 CHARACTERISTICS OF THE ZERO-TECHNOLOGY BASELINE TRACTOR-TRAILER VEHICLES

	Dry van		Refrigerated van		Non-aero box	Non-box
Trailer Length	Long	Short	Long	Short	All Lengths	All Lengths
Tractor Class	Class 8	Class 8	Class 8	Class 8	Class 8	Class 8
Tractor Cab Type	Sleeper	Day	Sleeper	Day	Day	Day
Tractor Roof Height	High	High	High	High	High	Low
Engine	2018 MY 15L, 455 HP	2018 MY 15L, 455 HP	2018 MY 15L, 455 HP	2018 MY 15L, 455 HP	2018 MY 15L, 455 HP	2018 MY 15L, 455 HP
Frontal Area (m^2)	10.4	10.4	10.4	10.4	10.4	6.9
Drag Area, C_DA (m^2)	6.2	6.1	6.1	6.0	6.1	4.9
Steer Tire RR (kg/ton)	6.54	6.54	6.54	6.54	6.54	6.54
Drive Tire RR (kg/ton)	6.92	6.92	6.92	6.92	6.92	6.92
Trailer Tire RR (kg/ton)	6.00	6.00	6.00	6.00	6.00	6.00
Total Weight (kg)	31,978	21,028	33,778	22,828	21,028	29,710
Payload (tons)	19	10	19	10	10	19
ATI System Use	0	0	0	0	0	0
Weight Reduction (lb)	0	0	0	0	0	0
Drive Cycle Weightings						
65-MPH Cruise	86%	64%	86%	64%	64%	64%
55-MPH Cruise	9%	17%	9%	17%	17%	17%
Transient Driving	5%	19%	5%	19%	19%	19%

(b) Effectiveness of Technologies

The agencies are proposing to recognize trailer improvements via four performance parameters: aerodynamic drag reduction, tire rolling resistance reduction, the adoption of ATI systems, and by substituting specific weight-reducing components. Table IV–8 summarizes the performance levels for each of these parameters based on the technology characteristics outlined in Section IV. D. (2) .

[232] Scarcelli, Jamie. ''Fuel Efficiency for Trailers'' Presented at ACEEE/ICCT Workshop: Emerging Technologies for Heavy-Duty Vehicle Fuel Efficiency, Wabash National Corporation. July 22, 2014.

[233] ''Weight Reduction: A Glance at Clean Freight Strategies'', EPA SmartWay. EPA420F09–043. Available at: *http://permanent.access.gpo.gov/gpo38937/EPA420F09-043.pdf.*

[234] Memorandum dated June 2015 regarding confidential weight reduction information obtained during SBREFA Panel. Docket EPA–HQ–OAR–2014–0827.

[235] Randall Scheps, Aluminum Association, ''The Aluminum Advantage: Exploring Commercial Vehicles Applications,'' presented in Ann Arbor, Michigan, June 18, 2009

TABLE IV—8 PERFORMANCE PARAMETERS FOR THE PROPOSED TRAILER PROGRAM

Aerodynamics (Delta C_DA, m^2):	
Bin I	0.0.
Bin II	0.1.
Bin III	0.3.
Bin IV	0.5.
Bin V	0.7.
Bin VI	1.0.
Bin VII	1.4.
Bin VIII	1.8.
Tire Rolling Resistance (C_{RR}, kg/ton):	
Tire Baseline	6.0.
Tire Level 1	5.1.
Tire Level 2	4.7.
Tire Inflation System (% reduction):	
ATI System	1.5.
Weight Reduction (lbs):	
Weight	1/3 added to payload, remaining reduces overall vehicle weight.

These performance parameters have different effects on each trailer subcategory due to differences in the simulated trailer characteristics. Table IV–9 shows the agencies' estimates of the effectiveness of each parameter for the four box trailer subcategories. Each technology was evaluated using the baseline parameter values for the other technology categories. For example, each aerodynamic bin was evaluated using the baseline tire (6.0 kg/ton) and the baseline weight reduction option (zero lbs). The table shows that aerodynamic improvements offer the largest potential for CO_2 emissions and fuel consumption reductions, making them relatively effective technologies.

TABLE IV–9—EFFECTIVENESS (PERCENT CO_2 AND FUEL SAVINGS FROM BASELINE) OF TECHNOLOGIES FOR THE PROPOSED TRAILER PROGRAM

Aerodynamics	Delta C_DA (m^2)	Dry van		Refrigerated van	
		Long	Short	Long	Short
Bin I	0.0	0%	0%	0%	0%
Bin II	0.1	−1	−1	−1	−1
Bin III	0.3	−2	−2	−2	−2
Bin IV	0.5	−3	−4	−3	−3
Bin V	0.7	−5	−5	−5	−5
Bin VI	1.0	−7	−7	−7	−7
Bin VII	1.4	−10	−10	−9	−10
Bin VIII	1.8	−13	−13	−12	−12
Tire Rolling Resistance	C_{RR} (kg/ton)	Dry van		Refrigerated van	
		Long	Short	Long	Short
Baseline	6.0	0	0	0	0
Level 1	5.1	−2	−1	−2	−1
Level 2	4.7	−3	−2	−3	−2
Weight Reduction	Weight (lb)	Dry van		Refrigerated van	
		Long	Short	Long	Short
Baseline	0.0	0.0	0.0	0.0	0.0
Al. Dual Wheels	168	−0.2	−0.3	−0.2	−0.3
Upper Coupler	280	−0.3	−1	−0.3	−1
Suspension	430	−0.5	−1	−0.5	−1
Al. Single Wide	556	−1	−1	−1	−1

(c) Reference Tractor-Trailer To Evaluate Benefits and Costs

In order to evaluate the benefits and costs of the proposed standards, it is necessary to establish a reference point for comparison. As mentioned previously, the technologies described in Section IV. D. (2) exist in the market today, and their adoption is driven by available fuel savings as well as by the voluntary SmartWay Partnership and California's tractor-trailer requirements. For this proposal, the agencies identified reference case tractor-trailers for each trailer subcategory based on the technology adoption rates we project would exist if this proposed trailer program was not implemented.

We project that by 2018, absent further California regulation, EPA's SmartWay program and these research programs will result in about 20 percent of 53-foot dry and refrigerated vans adopting basic SmartWay-level aerodynamic technologies (meeting SmartWay's four percent verification level and Bin III from Table IV–5), 30 percent adopting more advanced aerodynamic technologies at the five percent SmartWay-verification level (Bin IV from Table IV–5) and five percent adding combinations of technologies (Bin V).[236] [237] [238] In addition, we project half of these 53' box trailers will be equipped with SmartWay-verified tires (*i.e.,* 5.1 kg/ton or better) and ATI systems as well. The agencies project that market forces will drive an additional one percent increase in adoption of the advanced SmartWay and tire technologies each year through 2027. For analytical purposes, the agencies assumed manufacturers of the shorter box trailers and other trailer

[236] Truck Trailer Manufacturers Association letter to EPA. Received on October 16, 2014. Docket EPA–HQ–OAR–2014–0827.

[237] Ben Sharpe (ICCT) and Mike Roeth (North American Council for Freight Efficiency), ''Costs and Adoption Rates of Fuel-Saving Technologies for Trailer in the North American On-Road Freight Sector'', Feb 2014.

[238] Frost & Sullivan, ''Strategic Analysis of North American Semi-trailer Advanced Technology Market'', Feb 2013.

subcategories would not adopt these technologies in the timeframe considered and a zero-technology baseline is assumed. We are not assuming weight reduction for any of the trailer subcategories in the reference cases. Table IV–10 summarizes the reference case trailers for each trailer subcategory.

TABLE IV–10—PROJECTED ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR THE LESS DYNAMIC REFERENCE CASE TRAILERS

Technology / Model Year	Long box dry & refrigerated vans 2018	2021	2024	2027	Short box, non-aero box, & non-box trailers 2018–2027
Aerodynamics:					
Bin I	45%	41%	38%	35%	100%
Bin II					
Bin III	20	20	20	20	
Bin IV	30	34	37	40	
Bin V	5	5	5	5	
Bin VI					
Bin VII					
Bin VIII					
Average Delta C_DA (m^2) [a]	*0.2*	*0.3*	*0.3*	*0.3*	*0.0*
Tire Rolling Resistance:					
Baseline tires	50	47	43	40	100
Level 1 tires	50	53	57	60	
Level 2 tires					
Average C_{RR} (kg/ton) [a]	*5.55*	*5.52*	*5.49*	*5.46*	*6.0*
Tire Inflation:					
ATI	50	53	57	60	0
Average % Reduction [a]	*0.8*	*0.8*	*0.9*	*0.9*	*0.0*
Weight Reduction (lbs):					
Weight [b]					

Notes: A blank cell indicates a zero value.
[a] Combines adoption rates with performance levels shown in Table IV–8.
[b] Weight reduction was not projected for the reference case trailers.

Also shown in Table IV–10 are average aerodynamic performance (delta C_DA), average tire rolling resistance (C_{RR}), and average reductions due to use of ATI and weight reduction for each stage of the proposed program. These values indicate the performance of theoretical average tractor-trailers that the agencies project will be in use if no federal regulations were in place for trailer CO_2 and fuel consumption. The average tractor-trailer vehicles serve as reference cases for each trailer subcategory. The agencies provide a detailed description of the development of these reference case vehicles in Chapter 2.10 in the draft RIA.

Because the agencies cannot be certain about future trends, we also considered a second reference case. This more dynamic reference case reflects the possibility that absent a Phase 2 regulation, there will be continuing adoption of technologies in the trailer market after 2027 that reduce fuel consumption and CO_2 emissions. This case assumes the research funded and conducted by the federal government, industry, academia and other organizations will, after 2027, result the adoption of some technologies beyond the levels required to comply with existing regulatory and voluntary programs. One example of such research is the Department of Energy Super Truck program which has a goal of demonstrating cost-effective measures to improve the efficiency of Class 8 long-haul freight trucks by 50 percent by 2015.[239] This reference case assumes that by 2040, 75 percent of new trailers will be equipped with SmartWay-verified aerodynamic devices, low rolling resistance tires, and ATI systems. Table IV–11 shows the agencies' projected adoption rates of technologies in the more dynamic reference case.

TABLE IV–11—PROJECTED ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR THE MORE DYNAMIC REFERENCE CASE

Technology / Model year	Long box dry & refrigerated vans 2018	2021	2024	2027	2040	Short box, non-aero box, & non-box trailers 2018–2027
Aerodynamics:						
Bin I	45%	41%	38%	35%	20%	100%
Bin II						
Bin III	20	20	20	20	20	

[239] Daimler Truck North America. SuperTruck Program Vehicle Project Review. June 19, 2014. Docket EPA–HQ–OAR–2014–0827.

TABLE IV–11—PROJECTED ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR THE MORE DYNAMIC REFERENCE CASE—Continued

Technology	Long box dry & refrigerated vans					Short box, non-aero box, & non-box trailers
Model year	2018	2021	2024	2027	2040	2018–2027
Bin IV	30	34	37	40	55	
Bin V	5	5	5	5	5	
Bin VI						
Bin VII						
Bin VIII						
Average Delta $C_D A$ (m²) [a]	*0.2*	*0.3*	*0.3*	*0.3*	*0.4*	*0.0*
Tire Rolling Resistance:						
Baseline tires	50	47	43	40	25	100
Level 1 tires	50	53	57	60	75	
Level 2 tires						
Average C_{RR} (kg/ton) [a]	*5.6*	*5.5*	*5.5*	*5.5*	*5.3*	*6.0*
Tire Inflation:						
ATI	50	53	57	60	75	0
Average % Reduction [a]	*0.8*	*0.8*	*0.9*	*0.9*	*1.1*	*0.0*
Weight Reduction (lbs):						
Weight [b]						

Notes: A blank cell indicates a zero value.
[a] Combines adoption rates with performance levels shown in Table IV–8.
[b] Weight reduction was not projected for the reference case trailers.

The agencies applied the vehicle attributes from Table IV–7 and the average performance values from Table IV–10 in the proposed Phase 2 GEM vehicle simulation to calculate the CO_2 emissions and fuel consumption performance of the reference tractor-trailers. The results of these simulations are shown in Table IV–12. We used these CO_2 and fuel consumption values to calculate the relative benefits of the proposed standards. Note that the large difference between the per ton-mile values for long and short trailers is due primarily to the large difference in assumed payload (19 tons compared to 10 tons) as seen in Table IV–7 and discussed further in the Chapter 2.10.3. The alternative reference case shown in Table IV–11 impacts the long-term projections of benefits beyond 2027, which are analyzed in Chapters 5–7 of the draft RIA.

TABLE IV–12—CO_2 EMISSIONS AND FUEL CONSUMPTION RESULTS FOR THE REFERENCE TRACTOR-TRAILERS

Length	Dry van		Refrigerated van	
	Long	Short	Long	Short
CO_2 Emissions (g/ton-mile)	85	147	87	151
Fuel Consumption (gal/1000 ton-miles)	8.3497	14.4401	8.5462	14.8330

(d) Projected Technology Adoption Rates for the Proposed Standards

As described in Section IV. E., the agencies evaluated several alternatives for the proposed trailer program. Based on our analysis, and current information, the agencies are proposing the alternative we believe reflects the agencies' respective statutory authorities. The agencies are also considering an accelerated alternative with less lead time, requiring the same incremental stringencies for the proposed program, but becoming effective three years earlier. The agencies believe this alternative has the potential to be the maximum feasible alternative. However, based on the evidence currently before us, EPA and NHTSA have outstanding questions regarding relative risks and benefits of Alternative 4 due to the timeframe envisioned by that alternative. EPA and NHTSA are seriously considering this accelerated alternative in whole or in part for the trailer segment. In other words, the agencies could determine that less lead-time is maximum feasible in the final rule. We request comment on these two alternatives, including the proposed lead-times.

Table IV–13 and Table IV–14 present a set of assumed adoption rates for aerodynamic, tire, and ATI technologies that a manufacturer could apply to meet the proposed standards. These adoption rates begin with 60 percent of long box trailers achieving current SmartWay level aerodynamics (Bin IV) and progress to 90 percent achieving SmartWay Elite (Bin VI) or better over the following nine years. The adoption rates for short box trailers assume adoption of single aero devices in MY 2021 and combinations of devices by MY 2027. Although the shorter lengths of these trailers can restrict the design of aerodynamic technologies that fully match the SmartWay-like performance levels of long boxes, we nevertheless expect that trailer and device manufacturers would continue to innovate skirt, under-body, rear, and gap-reducing devices and combinations to achieve improved aerodynamic performance on these shorter trailers. The assumed adoption rates for aerodynamic technologies for both long and short refrigerated vans are slightly less than for dry vans, reflecting the more limited number of aerodynamic options due to the presence of their TRUs.

The gradual increase in assumed adoption of aerodynamic technologies throughout the phase-in to the MY 2027 standards recognizes that even though many of the technologies are available today and technologically feasible throughout the phase-period, their adoption on the scale of the proposed program would likely take time. The adoption rates we are assuming in the interim years—and the standards that we developed from these rates—represent steady and yet reasonable improvement in average aerodynamic performance.

The agencies project that nearly all box trailers will adopt tire technologies to comply with the standards and the agencies projected consistent adoption rates across all lengths of dry and refrigerated vans, with more advanced (Level 2) low-rolling resistance tires assumed to replace Level 1 tire models in the 2024 time frame, as Level 2-type tires become more available and fleet experience with these tires develops. As mentioned previously, the agencies did not include weight reduction in their technology adoption projections, but certain types of weight reduction could be used as a compliance pathway, as discussed in Section IV.D.1.d above.

The adoption rates shown in these tables are one set of many possible combinations that box trailer manufacturers could apply to achieve the same average stringency. If a manufacturer chose these adoption rates, a variety of technology options exist within the aerodynamic bins, and several models of LRR tires exist for the levels shown. Alternatively, technologies from other aero bins and tire levels could be used to comply. It should be noted that manufacturers are not limited to aerodynamic and tire technologies, since these are performance-based standards, and manufacturers would not be constrained to adopt any particular way to demonstrate compliance. Certain types of weight reduction, for example, may be used as a compliance pathway, as discussed in Section IV.D.1.d above.

Similar to our analyses of the reference cases, the agencies derived a single set of performance parameters for each subcategory by weighting the performance levels included in Table IV–8 by the corresponding adoption rates. These performance parameters represent an average compliant vehicle for each trailer subcategory and we present these values in the tables. The 2024 MY adoption rates would continue to apply for the partial-aero box trailers in 2027 and later model years.

TABLE IV–13—PROJECTED ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR LONG BOX TRAILERS

Technology	Long box dry vans				Long box refrigerated vans			
Model year	2018	2021	2024	2027	2018	2021	2024	2027
Aerodynamic Technologies:								
Bin I	5%				5%			
Bin II								
Bin III	30%	5%			30%	5%		
Bin IV	60%	55%	25%		60%	55%	25%	
Bin V	5%	10%	10%	10%	5%	10%	10%	20%
Bin VI		30%	65%	50%		30%	65%	60%
Bin VII				40%				20%
Bin VIII								
Average Delta C_DA (m²) [a]	*0.4*	*0.7*	*0.8*	*1.1*	*0.4*	*0.7*	*0.8*	*1.0*
Trailer Tire Rolling Resistance:								
Baseline tires	15%	5%	5%	5%	15%	5%	5%	5%
Level 1 tires	85%	95%			85%	95%		
Level 2 tires			95%	95%			95%	95%
Average C_{RR} (kg/ton) [a]	*5.2*	*5.1*	*4.8*	*4.8*	*5.2*	*5.1*	*4.8*	*4.8*
Tire Inflation System:								
ATI	85	95	95	95	85	95	95	95
Average ATI Reduction (%) [a]	*1.3%*	*1.4%*	*1.4%*	*1.4%*	*1.3%*	*1.4%*	*1.4%*	*1.4%*
Weight Reduction (lbs):								
Weight [b]								

Notes: A blank cell indicates a zero value.
[a] Combines projected adoption rates with performance levels shown in Table IV–8.
[b] This set of proposed adoption rates did not apply any assumed weight reduction to meet the proposed standards for these trailers.

TABLE IV–14—PROJECTED ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR SHORT BOX TRAILERS

Technology	Short box dry vans				Short box refrigerated vans			
Model year	2018	2021	2024	2027	2018	2021	2024	2027
Aerodynamic Technologies: [a]								
Bin I	100%	5%			100%	5%		
Bin II		95%	70%	30%		95%	70%	55%
Bin III			30%	60%			30%	40%
Bin IV				10%				5%
Bin V								
Bin VI								
Bin VII								
Bin VIII								
Average Delta C_DA (m²) [b]	*0.4*	*0.7*	*0.8*	*1.1*	*0.4*	*0.7*	*0.8*	*1.0*
Trailer Tire Rolling Resistance:								
Baseline tires	15%	5%	5%	5%	15%	5%	5%	5%
Level 1 tires	85%	95%			85%	95%		
Level 2 tires			95%	95%			95%	95%
Average C_{RR} (kg/ton) [b]	*5.2*	*5.1*	*4.8*	*4.8*	*5.2*	*5.1*	*4.8*	*4.8*

TABLE IV–14—PROJECTED ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR SHORT BOX TRAILERS—Continued

Technology	Short box dry vans				Short box refrigerated vans			
Model year	2018	2021	2024	2027	2018	2021	2024	2027
Tire Inflation System:								
ATI	85%	95%	95%	95%	85%	95%	95%	95%
Average ATI Reduction (%) [c]	*1.3%*	*1.4%*	*1.4%*	*1.4%*	*1.3%*	*1.4%*	*1.4%*	*1.4%*
Weight Reduction (lbs):								
Weight [b]								

Notes: A blank cell indicates a zero value.
[a] The majority of short box trailers are 28 feet in length. We recognize that they are often operated in tandem, which limits the technologies that can be applied (for example, boat tails).
[b] Combines projected adoption rates with performance levels shown in Table IV–8.
[c] This set of proposed adoption rates did not apply any assumed weight reduction to meet the proposed standards for these trailers.

Non-aero box trailers, with two or more work-related special components, and non-box trailers are not shown in the tables above. We are proposing that manufacturers of these trailers meet design-based (*i.e.,* technology-based) standards, instead of performance-based standards that would apply to other trailers. That is, manufacturers of these trailers would not need to use aerodynamic technologies, but they would need to use appropriate lower rolling resistance tires and ATI systems, based on our assessments of the typical CO_2 and fuel consumption performance of this equipment (see Section IV.2.c). Thus, we are projecting 100 percent adoption rates of these technologies at each stage of the program. Compared to manufacturers that needed aerodynamic technologies to comply, the approach for non-aero box trailers and non-box trailers would result in a significantly lower compliance burden for manufacturers by reducing the amount of tracking and eliminating the need to calculate a compliance value (see Section IV. F.). The agencies are proposing these design standards in two stages. In 2018, the proposed standards would require manufacturers to use tires meeting a rolling resistance of Level 1 or better and to install ATI systems on all non-box and non-aero box trailers. In 2024, the proposed standards would require manufacturers to use LRR tires at a Level 2 or better, and to still install ATI systems. We seek comment on all aspects of this design-based standards concept. We also seek comment on providing manufacturers with the option of adopting Level 2 tires in the early years of the program (MY 2018–2023) and avoiding the use of ATI systems if they chose.

TABLE IV–15—PROJECTED ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR NON-AERO BOX AND NON-BOX TRAILERS

Technology	Non-aero box & non-box trailers			
Model year	2018	2021	2024	2027
Aerodynamic Technologies:				
Bin I	100%	100%	100%	100%
Bin II				
Bin III				
Bin IV				
Bin V				
Bin VI				
Bin VII				
Bin VIII				
Average Delta C_DA (m^2) [a]	*0.0*	*0.0*	*0.0*	*0.0*
Trailer Tire Rolling Resistance:				
Baseline tires				
Level 1 tires	100%	100%		
Level 2 tires			100%	100%
Average C_{RR} (kg/ton) [a]	*5.1*	*5.1*	*4.7*	*4.7*
Tire Inflation System:				
ATI	100%	100%	100%	100%
Average ATI Reduction (%) [a]	1.5%	1.5%	1.5%	1.5%
Weight Reduction (lbs):				
Weight [b]				

Notes: A blank cell indicates a zero value.
[a] Combines projected adoption rates with performance levels shown in Table IV–8.
[b] This set of adoption rates did not apply weight reduction to meet the proposed standards for these trailers.

We request comment and any data related to our projections of technology adoption rates. The following section (d) explains how the agencies combined these adoption rates with the performance values shown previously to calculate the proposed standards.

(e) Derivation of the Proposed Standards

The average performance parameters from Table IV–14, and Table IV–15 were applied as input values to the GEM vehicle simulation to derive the proposed HD Phase 2 fuel consumption and CO_2 emissions standards for each subcategory of trailers. The proposed standards are shown in Table IV–16. The proposed standards for partial-aero trailers, which are not explicitly shown in Table IV–16, would be the same as their full-aero counterparts through MY 2026. In MY 2027 and later, partial aero trailers would continue to meet the MY 2024 standards.

Over the four stages of the proposed rule, box trailers longer than 50 feet would, on average, reduce their CO_2 emissions and fuel consumption by two percent, four percent, seven percent and eight percent compared to their reference cases. Box trailers 50-feet and shorter would achieve reductions of two percent, three percent and four percent compared to their reference cases. The tire technologies used on non-box and non-aero box trailers would provide reductions of two percent in the first two stages and achieve three percent by 2027.

TABLE IV–16—PROPOSED STANDARDS FOR BOX TRAILERS

Model year	Subcategory	Dry van		Refrigerated van	
	Length	Long	Short	Long	Short
2018—2020	EPA Standard (CO_2 Grams per Ton-Mile)	83	144	84	147
	Voluntary NHTSA Standard (Gallons per 1,000 Ton-Mile).	8.1532	14.1454	8.2515	14.4401
2021—2023	EPA Standard (CO_2 Grams per Ton-Mile)	81	142	82	146
	NHTSA Standard (Gallons per 1,000 Ton-Mile).	7.9568	13.9489	8.0550	14.3418
2024—2026	EPA Standard (CO_2 Grams per Ton-Mile)	79	141	81	144
	NHTSA Standard (Gallons per 1,000 Ton-Mile).	7.7603	13.8507	7.9568	14.1454
2027 +	EPA Standard (CO_2 Grams per Ton-Mile)	77	140	80	144
	NHTSA Standard (Gallons per 1,000 Ton-Mile).	7.5639	13.7525	7.8585	14.1454

It should be noted that the proposed standards are based on highway cruise cycles that include road grade to better reflect real world driving and to help recognize engine and driveline technologies. See Section III.E. The agencies have evaluated some alternate road grade profiles recommended by the National Renewable Energy Laboratory (NREL) and have prepared possible alternative trailer vehicle standards based on these profiles. The agencies request comment on this analysis, which is available in a memorandum to the docket.[240]

(f) Technology Costs for the Proposed Standards

The agencies evaluated the technology costs for 53-foot dry and refrigerated vans and 28-foot dry vans, which we believe are representative of the majority of trailers in the 50-foot and longer and shorter than 50-foot categories, respectively. We identified costs for each technology package evaluated and projected the costs for each year of the program. A summary of the technology costs is included in Table IV–17 through Table IV–20 for MYs 2018 through 2027, with additional details available in the draft RIA Chapter 2.12. Costs shown in the following tables are for the specific model year indicated and are incremental to the average reference case costs, which includes some level of adoption of these technologies as shown in Table IV–13. Therefore, the technology costs in the following tables reflect the average cost expected for each of the indicated trailer classes. Note that these costs do not represent actual costs for the individual components because some fraction of the component costs has been subtracted to reflect some use of these components in the reference case. For more on the estimated technology costs exclusive of adoption rates, refer to Chapter 2.12 of the draft RIA. These costs include indirect costs via markups and reflect lower costs over time due to learning impacts. For a description of the markups and learning impacts considered in this analysis and how technology costs for other years are thereby affected, refer to Chapter 7 of the draft RIA. We welcome comment on the technology costs, markups, and learning impacts.

TABLE IV–17—TRAILER TECHNOLOGY INCREMENTAL COSTS IN THE 2018 MODEL YEAR

[2012$]

	53-foot dry van	53-foot refrigerated van	28-foot dry van	Non-aero & non-box
Aerodynamics	$285	$285	$0	$0
Tires	65	65	78	185
Tire inflation system	239	239	435	683
Total	588	588	514	868

[240] Memorandum dated May 2015 on Analysis of Possible Tractor, Trailer, and Vocational Vehicle Standards Based on Alternative Road Grade Profiles. Docket EPA–HQ–OAR–2014–0827.

TABLE IV–18—TRAILER TECHNOLOGY INCREMENTAL COSTS IN THE 2021 MODEL YEAR

[2012$]

	53-foot dry van	53-foot refrigerated van	28-foot dry van	Non-aero & non-box
Aerodynamics	$602	$602	$468	$0
Tires	65	65	79	175
Tire inflation system	234	234	426	632
Total	901	901	974	807

TABLE IV–19—TRAILER TECHNOLOGY INCREMENTAL COSTS IN THE 2024 MODEL YEAR

[2012$]

	53-foot dry van	53-foot refrigerated van	28-foot dry van	Non-aero & non-box
Aerodynamics	$836	$836	$608	$0
Tires	61	61	76	160
Tire inflation system	220	220	412	578
Total	1,116	1,116	1,097	739

TABLE IV–20—TRAILER TECHNOLOGY INCREMENTAL COSTS IN THE 2027 MODEL YEAR

[2012$]

	53-foot dry van	53-foot refrigerated van	28-foot dry van	Non-aero & non-box
Aerodynamics	$1,163	$1,034	$788	$0
Tires	54	54	74	155
Tire inflation system	192	192	391	549
Total	1,409	1,280	1,253	704

(4) Consistency of the Proposed Trailer Standards With the Agencies' Legal Authority

The agencies' initial determination, subject to consideration of public comment, is that the standards presented in the Section IV.C.2, are the maximum feasible and appropriate under the agencies' respective authorities, considering lead time, cost, and other factors. The agencies' proposed decisions on the stringency and timing of the proposed standards focused on available technology and the consequent emission reductions and fuel efficiency improvements associated with use of the technology, while taking into account the circumstances of the trailer manufacturing sector. Trailer manufacturers would be subject to first-time emission control and fuel consumption regulation under the proposed standards. These manufacturers are in many cases small businesses, with limited resources to master the mechanics of regulatory compliance. Thus, the agencies' proposal seeks to provide a reasonable time for trailer manufacturers to become familiar with the requirements and the proposed new compliance regime, given the unique circumstances of the industry and the compliance flexibilities and optional compliance mechanisms specially adapted for this industry segment that we are proposing.

The stringency of the standard is predicated on more widespread deployment of aerodynamic and tire technologies that are already in commercial use. The availability, feasibility, and level of effectiveness of these technologies are well-documented. Thus the agencies do not believe that there is any issue of technological feasibility of the proposed standards. Among the issues reflected in the agencies' proposal are considerations of cost and sufficiency of lead-time—including lead-time not only to deploy technological improvements, but also this industry sector to assimilate for the first time the compliance mechanisms of the proposed rule.

The highest cost shown in Table IV–20 is associated with the long dry vans. We project that the average cost per trailer to meet the proposed MY 2027 standards for these trailers would be about $1,400, which is less than 10 percent of the cost of a new dry van trailer (estimated to be about $20,000). Other trailer types have lower projected technology costs, and many have higher purchase prices. As a result, we project that the per-trailer costs for all trailers covered in this regulation will be less than 10 percent of the cost of a new trailer. This trend is consistent with the expected average control costs for Phase 2 tractors, which are also less than 10 percent of typical tractor costs (see Section III).

The agencies believe these technologies can be adopted at the rates the standards are predicated on within the proposed lead-time, as discussed above in Section IV.C.(3). Moreover, we project that most owners would rapidly recover the initial cost of these technologies due to the associated fuel savings, usually in less than two years, as shown in the payback analysis in Section IX. This payback period is generally considered reasonable in the trailer industry for investments that reduce fuel consumption.[241]

Overall, as discussed above in IV.D.3.c in the context of our assumed technology adoption rates, the gradual increase in stringency of the proposed trailer program over the phase-in period recognizes two important factors that the agencies carefully considered in developing this proposed rule. One factor is that assumed adoption of technologies many of the aerodynamic technologies that box trailer manufacturers would likely choose are available today and clearly technologically feasible throughout the phase-period. At the same time, we recognize that the adoption of these technologies across the industry scale envisioned by the proposed program would likely take time. The standards we are proposing in the interim years represent steady improvement in average aerodynamic performance toward the final MY 2027 standards.

E. Alternative Standards and Feasibility Considered

As discussed in Section X, the agencies evaluated several different regulatory alternatives representing different levels of stringency for the Phase 2 program. The results of the analysis of these proposed alternatives are discussed below in Section X of the preamble. The agencies believe each alternative is feasible from a technical standpoint. However, each successive alternative increases costs and complexity of compliance for the manufacturers, which can be a prohibitive burden on the large number of small businesses in the industry. Table IV–21 provides a summary of the alternatives considered in this proposal.

TABLE IV–21—SUMMARY OF ALTERNATIVES CONSIDERED FOR THE PROPOSED RULEMAKING

Alternative 1	No action alternative.
Alternative 2	Expand the use of aerodynamic and tire technologies at SmartWay levels to all 53-foot box trailers.
Alternative 3 (Proposed Alternative)	Adoption of advanced aerodynamic and tire technologies on all box trailers. Adoption of tire technologies on non-box trailers.
Alternative 4	Same technology and application assumptions as Alternative 3 with an accelerated introduction schedule.
Alternative 5	Aggressive adoption of advance aerodynamic and tire technologies for all box trailers. Adoption of aerodynamic and tire technologies for some tank, flatbed, and container chassis trailers. Adoption of tire technologies for the remaining non-box trailers.

While we welcome comment on any of these alternatives, we are specifically requesting comment on Alternative 4 for the trailer program identified as Alternative 4 above and in Section X. The same general technology effectiveness values were considered and much of the feasibility analysis was the same in this alternative and in the proposed alternative, but Alternative 4 applies the adoption rates of higher-performing aerodynamic technologies from Alternative 3 at earlier stages for box trailers. This accelerated alternative achieves the same final fuel consumption and CO_2 reductions as our proposed alternative three years in advance. The following sections detail the adoption rates, reductions and costs projected for this alternative.

(1) Effectiveness, Adoption Rates, and Technology Costs for Alternative 4

Alternative 4 includes the same trailer subcategories and same trailer technologies as the proposed alternative. Therefore, the zero-technology baseline trailers (Table IV–7), reference case trailers (Table IV–10) and performance levels (Table IV–8) described in Section IV. D. apply for this analysis as well. The following sections describe the adoption rates of this accelerated alternative and the associated benefits and costs.

(a) Projected Technology Adoption Rates for Alternative 4

The adoption rates and average performance parameters projected by the agencies for Alternative 4 are shown in Table IV–22 and Table IV–23. Adoption rates for non-aero box and non-box trailers remain unchanged from the proposed standards and they are not repeated in this section. From the tables, it can be seen that the 2018 MY aerodynamic technology adoption rates and the tire technology adoption rates for all model years are identical to those presented previously for the proposed standards. The aerodynamic projections for MY 2021 and MY 2024 in this accelerated alternative are the same as those projected for MY 2024 and MY 2027 of the proposed standards, but are applied three years earlier. In this alternative, the 2021 MY adoption rates would continue to apply for the partial-aero box trailers in 2024 and later model years.

TABLE IV–22—ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR THE LONG BOX TRAILERS IN ALTERNATIVE 4

Technology	Long box dry vans			Long box refrigerated vans		
Model year	2018	2021	2024	2018	2021	2024
Aerodynamic Technologies: [a]						
Bin I	5%			5%		
Bin II						
Bin III	30%			30%		
Bin IV	60%	25%		60%	25%	
Bin V	5%	10%	10%	5%	10%	20%
Bin VI		65%	50%		65%	60%

[241] Roeth, Mike, *et al.* ''Barriers to Increased Adoption of Fuel Efficiency Technologies in Freight Trucking''. July 2013. International Council for Clean Transportation. Available here: *http://www.theicct.org/sites/default/files/publications/ICCT-NACFE-CSS_Barriers_Report_Final_20130722.pdf.*

TABLE IV–22—ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR THE LONG BOX TRAILERS IN ALTERNATIVE 4—Continued

Technology	Long box dry vans			Long box refrigerated vans		
Model year	2018	2021	2024	2018	2021	2024
Bin VII			40%			20%
Bin VIII						
Average Delta C_DA (m²) [a]	*0.4*	*0.8*	*1.1*	*0.4*	*0.8*	*1.0*
Trailer Tire Rolling Resistance:						
Baseline tires	15	5	5	15	5	5
Level 1 tires	85	95		85	95	
Level 2 tires			95			95
Average C_{RR} (kg/ton) [a]	*5.2*	*5.1*	*4.8*	*5.2*	*5.1*	*4.8*
Tire Inflation System:						
ATI	85%	95%	95%	85%	95%	95%
Average ATI Reduction (%) [a]	*1.3%*	*1.4%*	*1.4%*	*1.3%*	*1.4%*	*1.4%*
Weight Reduction (lbs):						
Weight [b]						

Notes: A blank cell indicates a zero value.
[a] Combines adoption rates with performance levels shown in Table IV–8.
[b] This set of adoption rates did not apply weight reduction to meet the proposed standards for these trailers.

TABLE IV–23—ADOPTION RATES AND AVERAGE PERFORMANCE PARAMETERS FOR THE SHORT BOX TRAILERS IN ALTERNATIVE 4

Technology	Short box dry vans			Short box refrigerated vans		
Model Year	2018	2021	2024	2018	2021	2024
Aerodynamic Technologies [a]						
Bin I	100%			100%		
Bin II		70%	30%		70%	55%
Bin III		30%	60%		30%	40%
Bin IV			10%			5%
Bin V						
Bin VI						
Bin VII						
Bin VIII						
Average Delta C_DA (m²) [b]	*0.4*	*0.8*	*1.1*	*0.4*	*0.8*	*1.0*
Trailer Tire Rolling Resistance:						
Baseline tires	15%	5%	5%	15%	5%	5%
Level 1 tires	85%	95%		85%	95%	
Level 2 tires			95%			95%
Average C_{RR} (kg/ton) [b]	*5.2*	*5.1*	*4.8*	*5.2*	*5.1*	*4.8*
Tire Inflation System:						
ATI	85%	95%	95%	85%	95%	95%
Average ATI Reduction (%) [b]	*1.3%*	*1.4%*	*1.4%*	*1.3%*	*1.4%*	*1.4%*
Weight Reduction (lbs):						
Weight [c]						

Notes: A blank cell indicates a zero value.
[a] The majority of short box trailers are 28 feet in length. We recognize that they are often operated in tandem, which limits the technologies that can be applied (for example, boat tails).
[b] Combines adoption rates with performance levels shown in Table IV–8.
[c] This set of adoption rates did not apply weight reduction to meet the proposed standards for these trailers.

(b) Derivation of the Standards for Alternative 4

Similar to the proposed standards of Section IV. D. (3) (d), the agencies applied the technology performance values from Table IV–22 and Table IV–23 as GEM inputs to derive the proposed standards for each subcategory.

Table IV–24 shows the resulting standards for Alternative 4. Over the three phases of the alternative, box trailers longer than 50 feet would, on average, reduce their CO_2 emissions and fuel consumption by two percent, six percent and eight percent. Box trailers 50-foot and shorter would achieve reductions of two percent, three percent, and four percent compared to the reference case. Partial-aero box trailers would continue to be subject to the 2021 MY standards for MY 2024 and later. The non-aero box and non-box trailers would meet the same standards as shown in the proposed Alternative 3 and achieve the same two and three percent benefits as shown in the proposed alternative.

TABLE IV–24—TRAILER CO_2 AND FUEL CONSUMPTION STANDARDS FOR BOX TRAILERS IN ALTERNATIVE 4

Model year	Subcategory	Dry van		Refrigerated van	
	Length	Long	Short	Long	Short
2018–2020	EPA Standard (CO_2 Grams per Ton-Mile).	83	144	84	147
	Voluntary NHTSA Standard (Gallons per 1,000 Ton-Mile).	8.1532	14.1454	8.2515	14.4401
2021–2023	EPA Standard (CO_2 Grams per Ton-Mile).	80	142	81	145
	NHTSA Standard (Gallons per 1,000 Ton-Mile).	7.8585	13.9489	7.9568	14.2436
2024+	EPA Standard (CO_2 Grams per Ton-Mile).	77	140	80	144
	NHTSA Standard (Gallons per 1,000 Ton-Mile).	7.5639	13.7525	7.8585	14.1454

(c) Costs Associated With Alternative 4

A summary of the technology costs is included in Table IV–25 to Table IV–27for MYs 2018, 2021 and 2024, with additional details available in the draft RIA Chapter 2.12. Costs shown in the following tables are for the specific model year indicated and are incremental to the average reference case costs, which includes some level of adoption of these technologies as shown in Table IV–10. Therefore, the technology costs in the following tables reflect the average cost expected for each of the indicated trailer classes. Note that these costs do not represent actual costs for the individual components because some fraction of the component costs has been subtracted to reflect some use of these components in the reference case. For more on the estimated technology costs exclusive of adoption rates, refer to Chapter 2.12 of the draft RIA. These costs include indirect costs via markups and reflect lower costs over time due to learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to the draft RIA.

TABLE IV–25—TRAILER TECHNOLOGY INCREMENTAL COSTS IN THE 2018 MODEL YEAR FOR ALTERNATIVE 4

[2012$]

	53-foot dry van	53-foot refrigerated van	28-foot dry van	Non-aero & non-box
Aerodynamics	$285	$285	$0	$0
Tires	65	65	78	185
Tire inflation system	239	239	435	683
Total	588	588	514	868

TABLE IV–26—TRAILER TECHNOLOGY INCREMENTAL COSTS IN THE 2021 MODEL YEAR FOR ALTERNATIVE 4

[2012$]

	53-foot dry van	53-foot refrigerated van	28-foot dry van	Non-aero & non-box
Aerodynamics	$908	$908	$641	$0
Tires	65	65	79	175
Tire inflation system	234	234	426	632
Total	1,207	1,207	1,146	807

TABLE IV–27—TRAILER TECHNOLOGY INCREMENTAL COSTS IN THE 2024 MODEL YEAR FOR ALTERNATIVE 4

[2012$]

	53-foot dry van	53-foot refrigerated van	28-foot dry van	Non-aero & non-box
Aerodynamics	1,223	1,090	816	0
Tires	61	61	76	160
Tire inflation system	220	220	412	578
Total	1,504	1,371	1,304	739

The agencies believe Alternative 4 has the potential to be the maximum feasible and appropriate alternative. However, based on the evidence currently before us, EPA and NHTSA have outstanding questions regarding relative risks and benefits of Alternative 4 due to the timeframe envisioned by that alternative. As discussed earlier, the ability for manufacturers in this industry to broadly take the necessary technical steps while becoming familiar with first-time regulatory responsibilities may be significantly limited with three fewer years of lead-time. As reinforced in the SBAR Panel Report, this challenge would not be equal across the industry, often falling more heavily on smaller trailer manufacturers.

The agencies request comment on the feasibility and costs for trailer manufacturers to achieve the Alternative 4 standards by applying advanced aerodynamic technologies with three years less lead-time than Alternative 3 would provide. The agencies also request comment on particular burdens that these aggressive adoption rates could have on small business trailer manufacturers.

F. Trailer Standards: Compliance and Flexibilities

Under the proposed structure, trailer manufacturers would be required to obtain a certificate of conformity from EPA before introducing into commerce new trailers subject to the proposed new trailer CO_2 and fuel consumption standards. See CAA section 206(a). The certification process the agencies are proposing for trailer manufacturers is very similar in its basic structure to the process for the tractor program. This structure involves pre-certification activities, the certification application and its approval, and end-of-year reporting.

In this section, the agencies first describe how we developed compliance equations based on the GEM vehicle simulation tool and the general certification process, followed by a discussion of the proposed test procedures for measuring the performance of tires and aerodynamic technologies and how manufacturers would apply test results toward compliance and certification. The section closes with discussions of several other proposed certification and compliance provisions as well as proposed provisions to provide manufacturers with compliance flexibility.

(1) Trailer Compliance Using a GEM-Based Equation

The agencies are committed to introducing a compliance program for trailer manufacturers that is straightforward, technically robust, transparent, and that minimizes new administrative burdens on the industry. As described earlier in this section and in Chapter 4 of the draft RIA, GEM is a customized vehicle simulation model that EPA developed for the Phase 1 program to relate measured aerodynamic and tire performance values, as well as other parameters, to CO_2 and fuel consumption without performing full-vehicle testing. As with the Phase 1 and proposed Phase 2 tractor and vocational vehicle programs, the proposed trailer program uses GEM in evaluating emissions and fuel consumption in developing the proposed standards. However, unlike the tractor and vocational vehicle programs, we are not proposing to use GEM directly to demonstrate compliance with the trailer standards. Instead, we have developed an equation based on GEM that calculates CO_2 and fuel consumption from performance inputs, but without running the model.

For the proposed trailer program, the trailer characteristics that a manufacturer would supply to the equation are aerodynamic improvements (*i.e.,* a change in the aerodynamic drag area, delta C_DA), tire rolling resistance (*i.e.,* coefficient of rolling resistance, C_{RR}), the presence of an automatic tire inflation (ATI) system, and the use of light-weight components from a pre-determined list. The use of the equation would quantify the overall performance of the trailer in terms of CO_2 emissions and fuel consumption on a per ton-mile basis.

Chapter 2.10.6 of the draft RIA provides a full a description of the development and evaluation of the equation proposed for trailer compliance. Equation IV–1 is a single linear regression curve that can be used for all box trailers in this proposal. Unique constant values, C_1 through C_4, are applied for each of the trailer subcategories as shown in Table IV–28. Constant C_5 is equal to 0.985 for any trailer that installs an ATI system (accounting for the 1.5 percent reduction given for use of ATI) or 1.0 for trailers without ATI systems. This equation was found to accurately reproduce the results of GEM for each of the four box van subcategories and the agencies are proposing that trailer manufacturers use Equation IV–1 when calculating CO_2 for compliance. Manufacturers would use a conversion of 10,180 grams of CO_2 per gallon of diesel to calculate the corresponding fuel consumption values for compliance with NHTSA's regulations. See 40 CFR 1037.515 and 49 CFR 535.6.

$$y = [C_1 + C_2 \cdot (TRRL) + C_3 \cdot (\Delta C_D A) + C_4 \cdot (WR)] \cdot C_5 \qquad \text{(IV–1)}$$

TABLE IV–28—CONSTANTS FOR GEM-BASED TRAILER COMPLIANCE EQUATION

Trailer subcategory	C_1	C_2	C_3	C_4
Long Dry Van	77.4	1.7	−6.1	−0.001
Long Refrigerated Van	78.3	1.8	−6.0	−0.001
Short Dry Van	134.0	2.2	−10.5	−0.003
Short Refrigerated Van	136.3	2.4	−10.3	−0.003

The constants for long vans apply for all dry or refrigerated vans longer than 50-feet and the constants for short vans apply for all dry or refrigerated vans 50-feet and shorter. These long and short van constants are based on GEM-simulated tractors pulling 53-foot and solo 28-foot trailers, respectively. As a result, we are proposing that aerodynamic testing to obtain a trailer's performance parameters for Equation IV–1 be performed using consistent trailer sizes (*i.e.,* all lengths of short vans be tested as a solo 28-foot van, and all lengths of long vans be tested as a 53-foot van). More information about aerodynamic testing is provided in Section IV. F. (3).

(2) General Certification Process

Under the proposed process for certification, trailer manufacturers would be required to apply to EPA for certification and would provide performance test data (see 40 CFR 1037.205) in their applications.[242] A

[242] As with the tractor program, manufacturers would submit their applications to EPA, which

staff member from EPA's Compliance Division (in the Office of Transportation and Air Quality) would be assigned to each trailer manufacturer to help them through the compliance process. Although not required, we recommend that manufacturers arrange to meet with the agencies to discuss compliance plans and obtain any preliminary approvals (*e.g.,* appropriate test methods) before applying for certification.

Trailer manufacturers would submit their applications through the EPA VERIFY electronic database, and EPA would issue certificates based on the information provided. At the end of the model year, trailer manufacturers would submit an end-of-year report to the agencies to complete their annual obligations.

The proposed EPA certification provisions also contain provisions for applying to the NHTSA program. EPA and NHTSA would coordinate on any enforcement action required.

(a) Preliminary Considerations for Compliance

Prior to submitting an application for a certificate, a manufacturer would choose the technologies they plan to offer their customers, obtain performance information for these technologies, and identify any trailers in their production line that qualify for exclusion from the program.[243] Manufacturers that choose to perform aerodynamic or tire testing would obtain approval of test methods and perform preliminary testing as needed. During this time, the manufacturer would also decide the strategy they intend to use for compliance by identifying ''families'' for the trailers they produce. A family is a grouping of similar products that would all be subject to the same standard and covered by a single certificate.

At its simplest, the program would allow all products in each of the trailer subcategories to be certified as separate families. That is, long box dry vans, short box dry vans, long refrigerated vans, short refrigerated vans, non-box trailers, partial-aero trailers (long and short box, dry and refrigerated vans), and non-aero trailers, could each be certified as separate trailer families. If a manufacturer chooses this approach, all products within a family would need to meet or do better than the standards for that trailer subcategory. This is not to say that, for example, every long box dry van model would need to have identical technologies like skirts, tires, and tire inflation systems, but that every model in that family would need to have a combination of technologies that had performance representative of testing demonstrated for that family. (Because the manufacturer would not be using averaging provisions, a trailer that ''over-complied'' could not offset a trailer that did not meet that family's emission limit).

If a trailer manufacturer wishes to take advantage of the proposed averaging provisions, it could divide the trailer models in each of the standard box trailer categories (*i.e.,* not including the non-box trailer or non-aero box trailer categories[244]) into subfamilies. Each subfamily could be a grouping of trailers that have with similar performance levels, even if they use different technologies. We call the performance levels for each subfamily as ''Family Emission Limits'' (FELs). A long box dry van manufacturer could choose, for example, to create two or more subfamilies in its long box dry van family. Trailers in one or more of these subfamilies could be allowed to under-comply with the standard (*e.g.,* if the manufacturer chose not to apply ATI or chose tires with higher rolling resistance levels) as long as the performance of the other subfamilies over-comply with the standard (*e.g.,* if the manufacturer applied higher-performing skirts) such that the average of all of the subfamilies' FELs met or did better than the stringency for that family on a production-weighted basis. Section IV.F.6.a below further discusses how the proposed averaging program would function for any such trailer subfamilies.

b) Submitting a Certification Application and Request for a Certificate to EPA

Once the preliminary steps are completed, the manufacturer can prepare and submit applications to EPA for certificate of conformity for each of its trailer families. The contents of the application are specified in 40 CFR 1037.205, though not all items listed in the regulation are applicable to each trailer manufacturer.

For the early years of the program (*i.e.,* 2018 through 2020), the application must specify whether the trailer manufacturer is opting into the NHTSA voluntary program to ensure the information is transferred between the agencies. It must also include a description of the emission controls that a manufacturer intends to offer. These emission controls could include aerodynamic features, tire models, tire inflation systems or components that qualify for weight reduction. Basic information about labeling, warranty, and recommended maintenance should also be included the application (see Section IV.F.5 for more information).

The manufacturer would also provide a summary of the plans to comply with the standard. This information would include a description of the trailer family and subfamilies (if applicable) covered by the certificate and projected sales of its products. Manufacturers that do not participate in averaging would include information on the lowest level of CO_2 and fuel consumption performance offered in the trailer family. Manufacturers that choose to average within their families would include performance information for the projected highest production trailer configuration, as well as the lowest and the highest performing configurations within that trailer family.

(c) End-of-Year Obligations

After the end of each year, all manufacturers would need to submit a report to the agencies presenting production-related data for that year (see 40 CFR 1037.250 and 49 CFR 535.8). In addition, manufacturers participating in the averaging program would submit an end-of-year report containing both emissions and fuel consumption information for both agencies. This report would include the year's final compliance data (as calculated using the compliance equation) and actual sales in order to demonstrate that the trailers either met the standards for that year or that the manufacturer generated a deficit to be reconciled within the next three years under the averaging provisions (see 40 CFR 1037.730, 40 CFR 1037.745, and 49 CFR 535.7). All certifying manufacturers would need to maintain records of all the data and information required to be supplied to EPA and NHTSA for eight years.

(3) Trailer Certification Test Protocols

The Clean Air Act specifies that compliance with emission standards for motor vehicles be demonstrated using emission test data (see CAA section 206(a) and (b)). The Act does not require the use of specific technologies or designs. The agencies are proposing that the compliance equation shown in

would then share them with NHTSA. Obtaining an approved certificate of conformity from EPA is the first step in complying with the NHTSA program.

[243] Trailers that meet the qualifications for exclusion do not require a certificate of conformity and manufacturers do not have to submit an application to EPA for these trailers.

[244] The agencies are proposing that manufacturers implement 100 percent of their non-box and special purpose box trailers with automatic tire inflation systems and tires meeting the specified rolling resistance levels. As a result, averaging provisions do not apply to these trailer subcategories.

Section IV. F. (1) function as the official ''test procedure'' for quantifying CO_2 and fuel consumption performance for trailer compliance and certification (as opposed to GEM, which serves this function in the tractor and vocational vehicle programs). Manufacturers would insert performance information from the trailer technologies applied into the equation in order to calculate their impact on overall trailer performance. The agencies are proposing to assign performance levels to ATI systems and specific weight reduction values to pre-determined component substitutions. Aerodynamic and tire rolling resistance performance would be obtained by the trailer manufacturers. The following sections describe the approved performance tests for tire rolling resistance and aerodynamic drag. Non-box and non-aero box trailers have tire requirements only. Manufacturers of these trailers will only need to obtain results from the tire performance tests. Long and short box trailers are expected to use aerodynamic and tire technologies to meet the proposed standards and will need to obtain test results from both procedures. See generally proposed 40 CFR part 1037, subpart F, for full description of the proposed performance tests, and see in particular proposed section 40 CFR 1037.515.

(a) Trailer Tire Performance Testing

Under Phase 1, tractor and vocational chassis manufacturers are required to input the tire rolling resistance coefficient into GEM and the agencies adopted the provisions in ISO 28580:2009(E) [245] to determine the rolling resistance of tires. As described in 40 CFR 1037.520(c), this measured value, expressed as C_{RR}, is required to be the result of at least three repeat measurements of three different tires of a given design, giving a total of at least nine data points. Manufacturers specify a C_{RR} value for GEM that may not be lower than the average of these nine results. Tire rolling resistance may be determined by either the vehicle or tire manufacturer. In the latter case, the tire manufacturer would provide a signed statement confirming that it conducted testing in accordance with this part.

Similar to the tractor program, we propose to extend the Phase 1 testing provisions for tire rolling resistance to apply to the Phase 2 box trailer program, only without requiring the use of GEM. The average rolling resistance value obtained from this test would be used to specify the tire rolling resistance level (TRRL) for the trailer tires in the compliance equation. Based on the current practice for tractors, we expect the trailer manufacturers to obtain these data from tire manufacturers. We welcome comments regarding the proposed tire testing provisions as they relate to the proposed trailer program.

For non-box trailers, the agencies are proposing to use the same test methods to evaluate tires, but are proposing to apply a single threshold standard instead of inputting the rolling resistance value into the GEM equation. Manufacturers of non-box trailers would comply with the rolling resistance standard by using tires with rolling resistance below the threshold. From the perspective of the trailer manufacturer, this would be equivalent to a design standard for the trailers, even though the standard would be expressed as a performance standard for the tires.

The agencies are considering adopting a program for tire manufacturers similar to the provision described in Section IV. F. (3) (b)(iv) for aerodynamic device manufacturers. For aerodynamic devices, the agencies are proposing to allow device manufacturers to seek preliminary approval of the performance of their devices. Device manufacturers would perform the required testing of their device and submit the performance results directly to EPA. We are requesting comment on a similar provision for tires. Tire manufacturers could submit their test data directly to EPA to show they meet the rolling resistance requirements, and trailer manufacturers that choose to use approved tires would merely indicate that in their the certification applications.

EPA is also considering adopting regulatory text addressing obligations for tire manufacturers. We note that CAA section 207(c)(1) requires ''the manufacturer'' to remedy certain in-use problems and does not limit this responsibility to certificate holders. The remedy process is generally called recall, and the regulations for this process are in 40 CFR part 1068, subpart F. In the case of in-use problems with trailer tires, EPA is requesting comment on adding regulatory text that would explicitly apply these provisions to tire manufacturers. In other words, if EPA determines that tires on certified trailers do not conform to the regulations in actual use, should EPA require the tire manufacturer to recall and replace the nonconforming tires? [246]

(b) Trailer Aerodynamic Performance Testing

Our proposed trailer aerodynamic test procedures are based on the current and proposed tractor procedures for testing aerodynamic control devices, including coastdown, constant speed, wind tunnel, and computational fluid dynamics (CFD) modeling. The purpose of the tests is to establish an estimate of the aerodynamic drag experienced by a tractor-trailer vehicle in real-world operation. In the tractor program, the resulting CdA value represents the aerodynamic drag of a tested tractor assumed to be pulling a specified standard trailer. In the proposed trailer program, the C_DA value used in the compliance equation would represent the tested trailer pulled by a standard *tractor.*

To minimize the number of tests required, the agencies are proposing that devices for long trailers be evaluated based on 53-foot trailers, and that devices for short trailers be evaluated based on 28-foot trailers. Details of the test procedures can be found in 40 CFR 1037.525 and a discussion of EPA's aerodynamic testing program as it relates to the proposed trailer program are provided in the draft RIA Chapter 3.2. The following sections outline the testing requirements proposed for the long term trailer program, as well as simpler testing provisions that would apply in the nearer term.

(i) A to B Testing for Trailer Aerodynamic Performance

A key difference between the proposed tractor and trailer programs is that while the tractor procedures provide a direct measurement of an absolute C_DA value for each tractor model, the agencies expect a majority of the aerodynamic improvements for trailers will be accomplished by adding bolt-on technologies. As a result, we are proposing to evaluate the aerodynamic improvements for trailers by measuring a change in C_DA (delta C_DA) relative to a baseline. Specifically, we propose that the trailer tests be performed as ''A to B'' tests, comparing the aerodynamic performance of a tractor-trailer without a trailer aerodynamic device to one with the device installed. See Draft RIA Chapter 2.10 for more information on this approach.

As mentioned in Section IV. F. (1) that is consistent with the compliance

[245] *See http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=44770.*

[246] EPA is considering such a requirement for trailer tire manufacturers, but not at this time for manufacturers of other heavy-duty vehicle components. This is because, for the trailer sector, we believe that the small business trailer manufacturers that make up a large fraction of companies in this industry could be uniquely challenged if they needed to recall trailers to replace tires.

equations. See 40 CFR 1037.525 and 49 CFR 535.6. We believe that most trailers longer than 50 feet with comparable technologies would perform similarly in aerodynamic testing. We also recognize that devices used on some lengths of trailers in the short-van category may perform differently than those devices perform when used on a representative 28-foot test trailer.

The agencies are proposing that manufacturers have some flexibility in the devices (or packages of devices) that they use with box vans that have lengths different than those of the trailers on which the devices/packages were tested (*i.e.,* trailers not 53 or 28 feet long). In such situations, a manufacturer could use devices that they believe would be more appropriate for the length of the trailer they are producing, consistent with good engineering judgement. For example, they could use longer or shorter side skirts than those tested on 53- or 28-foot trailers. No additional testing would be required in order to validate the appropriateness of using the alternate devices on these trailers.

On average, we believe that testing of a device on a 28-foot test trailer would provide a conservative evaluation of the performance of that device on other lengths of short box trailers. We believe that the proposed compliance approach would effectively represent the performance of such devices on the majority of short van trailers, yet would limit the number of trailers a manufacturer would need to track and evaluate. We request comment, including data where possible, on additional approaches that could be used to address this issue of varying performance for devices across the range of short van lengths. Commenters supporting an allowance or requirement to test devices on short van trailers of other lengths than 28 feet are encouraged to also address how the agencies should consider such a provision in setting the levels of the standards, as well as how any additional compliance complexity would be justified.

The agencies note that it was relatively straightforward in Phase 1 to establish a standard trailer with enough specificity to ensure consistent testing of tractors, since there are relatively small differences in aerodynamic performance of base-model dry van trailers. However, as discussed in Chapter 2.10 of the draft RIA, small differences in tractor design can have a significant impact on overall tractor-trailer aerodynamic performance. An advantage of an A to B test approach for trailers is that many of the differences in tractor design are canceled-out, which allows a variety of standard tractors to be used in testing without compromising the evaluation of the trailer aerodynamic technology. Thus, the relative approach does not require the agencies to precisely specify a standard tractor, nor does it require trailer manufacturers to purchase, modify or retain a specific tractor model in order to evaluate their trailers.

In essence, an A to B test is a set of tests: one test of a baseline tractor-trailer with zero trailer aerodynamic technologies (A), and one test that includes the aerodynamic devices to be tested (B). However, because an A test would relate to a B test only with respect to the test method and the test trailer length, one A test could be used for many different B tests. This type of testing would result in a delta C_DA value instead of an absolute C_DA value. For the trailer program, the vehicle configuration in the A test would include a standard tractor that meets specified characteristics,[247] and a manufacturer's baseline trailer with no aerodynamic improvements. The entity conducting the testing (*e.g.,* the trailer manufacturer or the trailer aerodynamic device manufacturer, as discussed below) would perform the test for this configuration according to the procedures in 40 CFR 1037.525 and repeat the test for the B configuration, which includes the trailer aerodynamic package/device(s) being tested. The delta C_DA value for that trailer with that device would be the difference between the C_DA values obtained in the A and B tests.

In the event that a trailer manufacturer makes major changes to the aerodynamic design of its trailer in lieu of installing add-on devices, trailer manufacturers would use the same baseline trailer for the A configuration as would be used for bolt-on features. In both cases, the baseline trailer would be a manufacturer's standard box trailer. Thus, the manufacturer of a redesigned trailer would get full credit for any aerodynamic improvements it made. We request comment on this issue. In addition, we request comment on how the program could handle a situation in which a manufacturer made aerodynamic design changes to a trailer between 28 and 50 feet, which as proposed could only be compared to a 28-foot standard trailer.

The agencies are proposing to determine the delta C_DA for trailer aerodynamics using the zero-yaw (or head-on wind) values. The agencies are not proposing a reference method (*i.e.,* the coastdown procedure in the tractor program). Instead, we are proposing to allow manufacturers to perform any of the proposed test procedures to establish a delta C_DA. Since the proposed coastdown and constant speed procedures include wind restrictions, we are proposing to only accept the zero-yaw values from aerodynamic evaluation techniques that are capable of measuring drag at multiple yaw angles (*e.g.,* wind tunnels and CFD) to allow cross-method comparison and certification. The agencies welcome comment on the pros and cons of exclusive use of zero-yaw data from trailer aerodynamic compliance testing. We recognize that the benefits of aerodynamic devices can be higher when measured considering wind from other yaw angles. We request comment on the possibility of allowing manufacturers to use wind-averaged results for compliance if they choose to test using procedures that provide wind-averaged values. Chapter 2.10 of the draft RIA compares zero-yaw and wind-averaged results from EPA's wind tunnel testing. We request that commenters provide test data to support any preference for compliance test results. We also request comments on strategies that could be used to maintain consistency with other methods that cannot provide wind-averaged results.

(ii) Standard Tractor for Aerodynamic Testing in the Proposed Trailer Program

We propose that the proposed compliance equation, based on GEM, be used to determine compliance with the trailer standards. Our discussion of the feasibility of our proposed standards (Section IV. D. (3) (a)) includes a description of the tractor-trailer vehicle used in GEM. We recognize the impact of the tractor and want to maintain consistency with GEM, but for the trailer program it is not necessary to address all aspects (*e.g.,* the engine) of the tractor, because, as explained above, the impact of many of its features will be canceled-out with the use of an A to B test strategy. However, some aerodynamic design features of the tractor can influence the performance of trailer aerodynamic technologies and we want to ensure a level of consistency between tests of different trailer manufacturers.

The agencies believe the A to B test strategy would reduce the degree of precision with which the standard tractor needs to be specified. Instead of identifying a specific make and model of a tractor to be used over the entire duration of the program, the agencies

[247] As explained in Section IV. F. (3) (b)(ii), the standard tractor in GEM consists of a high roof sleeper cab for box trailers longer than 50 feet and a high roof day cab for box trailers 50 feet and shorter.

would instead identify key characteristics of a standard tractor. EPA's trailer testing program investigated the impact of tractor aerodynamics on the performance of trailer aerodynamic technologies, as mentioned in Chapter 2.10 of the draft RIA. In order to maintain a minimal level of performance, we are proposing that tractors used in trailer aerodynamic tests meet Phase 2 Bin III or better tractor requirements (see Section III.D.). We believe the majority of tractors in the U.S. trucking fleet will be Bin III or better in the timeframe of this rulemaking, and trailer manufacturers have the option to choose higher-performing tractors in later years as tractor technology improves. The standard tractor for long-box trailers is a Class 8 high-roof sleeper cab. The standard tractor for short box trailers is a Class 8 high roof day cab. Trailer manufacturers are free to choose any standard tractor that meets these criteria in their aerodynamic performance testing. See 40 CFR 1037.501.

(iii) Bins for Aerodynamic Performance

As mentioned in Section IV. D. (1) (a), the agencies are proposing aerodynamic bins to account for testing variability and to provide consistency in the performance values used for compliance. These bins were developed in terms of delta C_DA ranges, and designed to be broad enough to cover the range of uncertainty seen in our aerodynamic testing program in terms of test-to-test variability as well as variability due to differences in test method, tractor models, trailer models and device models.

As discussed in Chapter 2.10 of the draft RIA, measured drag coefficients and drag areas vary depending on the test method used. In general, values measured using wind tunnels and CFD tend to be lower than values measured using the coastdown method. The Phase 1 and proposed Phase 2 tractor program use coastdown testing as the reference test method, and the agencies require tractor manufacturers to perform at least one test using that method to establish a correction factor (called ''$F_{alt,aero}$'') to apply to any of the alternative test methods. For simplicity, the agencies are not proposing a similar approach for trailers. We believe that the size of the bins and the use of change in C_DA (as opposed to absolute values) would minimize the significance of this variability. However, we recognize that this could be a problem in instances where a manufacturer using a method other than coastdown produces a trailer with performance near the upper end of a bin. In such cases, it is possible that adjusting for methodological differences using a $F_{alt,aero}$ would allow the manufacturer to achieve a more stringent bin.

We request comment on the proposed approach for evaluating performance of trailers and establishing bins for trailer compliance. We specifically request that commenters address the need for an aerodynamic reference test for trailer performance or additional strategies for normalizing test methods. For example, would it be appropriate to allow all manufacturers using wind tunnel or CFD methods to apply an assigned $F_{alt,aero}$ of 1.10, or another value, to their results?

TABLE IV–29—AERODYNAMIC BINS USED TO DETERMINE INPUTS FOR TRAILER CERTIFICATION

Delta C_DA measured in testing	Bin	Average delta C_DA input for gem
0.09	Bin I	0.0
0.10–0.19	Bin II	0.1
0.20–0.39	Bin III	0.3
0.40–0.59	Bin IV	0.5
0.60–0.79	Bin V	0.7
0.80–1.19	Bin VI	1.0
1.20–1.59	Bin VII	1.4
≥ 1.6	Bin VIII	1.8

A manufacturer that wished to perform testing would first identify a standard tractor (according to 40 CFR 1037.525) and a representative baseline trailer with no aerodynamic features, then perform the A to B tests with and without aerodynamic devices and obtain a delta C_DA value. The manufacturer would use Table IV–29 to determine the appropriate bin based on their delta C_DA. Each bin has a corresponding average delta C_DA value which is the value manufacturers insert into the compliance equation.

(iv) Aerodynamic Device Testing Alternative

The agencies recognize that much of the trailer manufacturing industry may have little experience with aerodynamic performance testing. As such, we are proposing an alternative compliance option that we believe will minimize the testing burden for trailer manufacturers, meet the requirements of the Clean Air Act and of EISA, and provide reasonable assurance that the anticipated CO_2 and fuel consumption benefits of the program will be realized in real-world operation.

The agencies are proposing to allow trailer aerodynamic device manufacturers to seek preliminary approval of the performance of their devices (or combinations of devices) based on the same performance tests described previously in Section IV. F. (3) (b)(i). Device manufacturers would perform the required A to B testing of their device(s) on a trailer that meets the requirements specified in 40 CFR 1037.211 and 1037.525 and submit the performance results, in terms of delta C_DA, directly to EPA.[248] Trailer manufacturers could then choose to use these devices and apply their performance levels in the certification application for their trailer families. This approach would provide an opportunity for trailer manufacturers to choose technologies with pre-approved test data for installation on their new trailers without performing their own aerodynamic testing. We note that this proposed testing alternative is consistent with recommendations of the SBAR Panel. The Panel Report is summarized below in Section XV.D.

If trailer manufacturers wish to use multiple devices with pre-approved test data, the proposed program provides a process for combining the effects of multiple devices to determine an appropriate delta C_DA value for compliance. More specifically, such manufacturers would fully count the technology with largest delta C_DA value, discount the second by 10 percent, and discount each of the remaining additional technologies by 20 percent.[249] This discounting would acknowledge the complex interactions among individual aerodynamic devices and would provide a conservative value for the impact of the combined devices. For example, a manufacturer applying three separately tested devices with delta C_DA values of 0.40, 0.30, and 0.10 would calculate the combined delta C_DA as:

$$\text{Delta } C_DA = 0.40 + 0.90*0.30 + 0.80*0.10 = 0.75 \text{ m}^2$$

In addition, the agencies believe that discounting the delta C_DA values of individually-tested devices used as a combination would provide a modest incentive for trailer or device manufacturers to test and get EPA pre-approval of the combination as an aerodynamic system for compliance. We propose that device manufacturers be

[248] Note that in the event a device manufacturer chooses to submit such data to EPA, it could incur liability for causing a regulated entity to commit a prohibited act. See 40 CFR 1068.101(c). This same potential liability exists with respect to information provided by a device manufacturer directly to a trailer manufacturer.

[249] A trailer manufacturer would need to use good engineering judgement in combining devices for compliance in order to avoid combinations that are not intended to work together (*e.g.,* both a side skirt and an under-body device).

allowed to test and receive EPA pre-approval for combinations of devices, and that trailer manufacturers that wish to use those specific combinations be allowed to use the results from the tests of the combined devices.

The agencies note that many of the largest box trailer manufacturers are already performing aerodynamic test procedures to some extent, and the agencies expect other box trailer manufacturers will increasingly be capable of performing these tests as the program progresses.

The proposed alternative testing approach is intended to allow trailer manufacturers to focus on and become familiar with the certification process in the early years of the program and, if they wish, begin to perform testing in the later years, when it may be more appropriate for their individual companies. This approach would not preclude trailer manufacturers from performing their own testing at any time, even if the technologies they wish to install are already pre-approved. For example, a manufacturer that believed a specific trailer actually performed in a more synergistic manner with a given device than the device's pre-approved delta C_DA value suggested could perform its own testing and submit the results to EPA for certification. The process to obtain approval is outlined in the proposed 40 CFR 1037.211.

(4) Use of the Compliance Equation for Trailer Compliance

The agencies are proposing standards for non-box and non-aero box trailers requiring the use of tires with rolling resistance levels at or below a threshold, and on ATI systems. As part of their certification application, manufacturers of these trailers would submit their tire rolling resistance levels and a description of their ATI system(s) to EPA. As long as the trailer manufacturer certifies that they will install the appropriate tires and ATI systems on all of their trailers, the agencies do not believe it is necessary to require these trailer manufacturers to use the equation and report the results of the model to the agencies to demonstrate compliance.

Box trailer manufacturers who apply more than tire technologies to meet the standards would use the compliance equation to combine the effects of these technologies and quantify the overall performance of the vehicle to demonstrate compliance. Trailer manufacturers would obtain delta C_DA and tire rolling resistance values from testing (either from their own testing or testing performed by another entity as described previously) and note if they installed a qualifying automatic tire inflation system or made a component substitution that qualifies for weight reduction. Manufacturers would directly apply the delta C_DA and TRRL values into the equation, which would also recognize the use of an ATI system, applying a 1.5 percent reduction in CO_2 and fuel consumption. Qualifying components for weight reduction can be found in 40 CFR 1037.515(d). Manufacturers that substitute one or more of these components on their box trailers would sum the weight reductions assigned to each component and enter that total into the equation. The equation would also account for the use of weight-reducing components, assigning one-third of that reduced weight to increase the payload and the remaining weight reduction to reduce the overall weight of the assumed vehicle.

For this proposal, we are requiring that the equation be used if the manufacturer is to take advantage of the agencies' proposed averaging provisions. Prior to submitting a certificate application, manufacturers would decide which technologies to make available for their customers and use the equation to determine the range performance of the packages they will offer. Manufacturers would supply these results from the equation in their certificate application and those manufacturers that wish to perform averaging would continue to calculate emissions (and fuel consumption) with the equation throughout the model year and keep records of the results for each trailer package sold. As described in Section IV.F.2.c above, at the end of the year, manufacturers would submit two reports. One report would include their production volumes for each configuration. The second report, required for manufacturers using averaging, would summarize the families and subfamilies, and CO_2 emissions and fuel consumption results from the equation for all of the trailer configurations they build.[250]

Box trailer manufacturers that do not participate in averaging would also use the compliance equation to ensure that all of the trailer configurations they offer would meet the standard for the given model year. These calculations using the equation could be performed by the manufacturer prior to submitting a certificate application, but it is not necessary for the manufacturer to continue to calculate emissions and fuel consumption throughout the model year unless a new technology package is offered. These manufacturers would submit a single end-of-year report that would include their production volumes and confirmation that all of their trailers applied the technology packages outlined in their application.

(5) Additional Certification and Compliance Provisions

(a) Trailer Useful Life

Section 202(a)(1) of the CAA specifies that EPA is to propose emission standards that are applicable for the "useful life" of the vehicle. NHTSA also proposes to adopt EPA's useful life requirements for trailers to ensure manufacturers consider in the design process the need for fuel efficiency standards to apply for the same duration and mileage as EPA standards. Based on our own research and discussions with trailer manufacturers, EPA and NHTSA are proposing a regulatory useful life value for trailers of 10 years. This useful life represents the average duration of the initial use of trailers, before they are moved into less rigorous (*e.g.,* limited use or storage) duty. We note that the useful life value is 10 years for other heavy-duty vehicles. However, unlike the other vehicles, we are not proposing to set a mile value for trailers because we do not require odometers for trailers.

Thus, we propose that trailer manufacturers be responsible for meeting the CO_2 emissions and fuel consumption standards for 10 years after the trailer is produced. We believe that manufacturers would be able to demonstrate at certification that their trailers will comply for the useful life of the trailers without durability testing. The aerodynamic technologies that we expect manufacturers to use to comply with the proposed standards, including side skirts and boat tails, are designed to continue to provide their full potential benefit indefinitely as long as no serious damage occurs. See also Section IV.C.6 above describing why we are not proposing separate in-use standards.

Regarding trailer tires, we recognize that the original lower rolling resistance tires will wear over time and will be replaced several times during the useful life of a trailer, either with new or retreaded tires. As with the Phase 1 tractor program, to help ensure that trailer owners have sufficient knowledge of which replacement tires to purchase in order to retain the as-certified emission and fuel consumption

[250] We are not proposing to allow manufacturers to "bank" credits to the following year if a manufacturer over-complies on average for a given model year. We are proposing to allow manufacturers to generate temporary *deficits* if they under-comply on average. These deficits would need to be resolved within three model years. See Section IV.F.7.a below and 40 CFR 1037.250, 40 CFR 1037.730, and 49 CFR 535.7.

performance of their trailer for its useful life, we are proposing to require that trailer manufacturers supply adequate information in the owner's manual to allow the trailer owner to purchase replacement tires meeting or exceeding the rolling resistance performance of the original equipment tires. We believe that the favorable fuel consumption benefit of continued use of LRR tires would generally result in proper replacements throughout the 10-year useful life. Finally, we are requiring that ATI systems remain effective for at least the 10 year useful life, although some servicing may be necessary. See the maintenance discussion in Section IV.D.4.e.

(b) Emission Control Labels

Historically, EPA-certified vehicles are required to have a permanent emission control label affixed to the vehicle. The label facilitates the identification of the vehicle as a certified vehicle. For the trailer program, EPA proposes that the labels include the same basic information as we are proposing to require for tractor labels. For trailers, this information would include the manufacturer, a trailer identifier such as the Vehicle Identification Number, the trailer family and regulatory subcategory, the date of manufacture, and compliance statements. Although the proposed Phase 2 label for tractors would not include emission control system identifiers (as previously required for tractors in the Phase 1 program in 40 CFR 1037.135(c)(6)), we are proposing that these identifiers be included in the trailer labels. As for tractors, we would require manufacturers to maintain records that would allow us to verify that an individual trailer was in its certified configuration.

(c) Warranty

Section 207 of the CAA requires manufacturers to warrant their products to be free from defects that would otherwise cause non-compliance with emission standards. For purposes of the proposed trailer program, EPA would require trailer manufacturers to warrant all components that form the basis of the certification to the CO_2 emission standards. The emission-related warranty would cover all aerodynamic devices, lower rolling resistance tires, automatic tire inflation systems, and other components that may be included in the certification application.

The trailer manufacturer would need to warrant that these components and systems are designed to remain functional for the warranty period. Based on the historical practice of requiring emissions warranties to apply for half of the useful life, we propose that the warranty period for trailers be 5 years for everything except tires. For trailer tires, we propose to apply a warranty period of 1 year. Manufacturers could offer a more generous warranty if they chose; however the emissions related warranty may not be shorter than any other warranty offered without charge for the vehicle. If aftermarket components were installed (unrelated to emissions performance) that offer a longer warranty, this would not impact emission related warranty obligations of the vehicle manufacturer. NHTSA is not proposing any warranty requirements relating to its trailer fuel consumption program.

At the time of certification, manufacturers would need to supply a copy of the warranty statement that they would supply to the end customer. This document would outline what is covered under the GHG emissions related warranty as well as the duration of coverage. Customers would also have clear access to the terms of the warranty, the repair network, and the process for obtaining warranty service.

(d) Maintenance

In general, EPA requires that vehicle manufacturers specify maintenance schedules to keep their product in compliance with emission standards throughout the useful life of the vehicle (CAA section 207). For trailers, such maintenance could include fairing adjustments or service to ATI systems. However, EPA believes that any such maintenance is likely to be performed by operators to maintain the fuel savings of the components, and we are not proposing that trailer manufacturers be required submit a maintenance schedule for these components as part of its application for certification.

Since low rolling resistance tires are key emission control components under this program, and will likely require replacement at multiple points within the life of a vehicle, it is important to clarify how tires would fit into the emission-related maintenance requirements. Although the agencies encourage the exclusive use of LRR tires throughout the life of trailers vehicles, we do not propose to hold trailer manufacturers responsible for the actions of operators. We do not see this as problematic because we believe that trailer operators have a genuine financial motivation for ensuring their vehicles are as fuel efficient as possible, which includes purchasing LRR replacement tires. Therefore, as mentioned in Section IV.F.5.a above, to help ensure that trailer owners have sufficient knowledge of which replacement tires to purchase in order to retain the as-certified emission and fuel consumption performance of their trailer, we are proposing to require that trailer manufacturers supply adequate information in the owner's manual to allow the trailer owner to purchase tires meeting or exceeding the rolling resistance performance of the original equipment tires. We would require that these instructions be submitted to EPA as part of the application for certification.

(e) Post-Useful Life Modifications

Under 40 CFR part 1037, EPA generally prohibits for any person from removing or rendering inoperative any emission control device installed to comply with the requirements of 40 CFR part 1037. However, in 40 CFR 1037.655 EPA clarifies that certain vehicle modifications are allowed after a vehicle reaches the end of its regulatory useful life. EPA is proposing for this section to apply trailers, since it applies to all vehicles subject to 40 CFR part 1037, and requests comment on it.

Generally, this section clarifies that owners may modify a vehicle for the purpose of reducing emissions, provided they have a reasonable technical basis for knowing that such modification will not increase emissions of any other pollutant. In the case of trailers, this essentially requires a trailer owner to have information that would lead an engineer or other person familiar with trailer design and function to reasonably believe that the modifications will not increase emissions of any regulated pollutant. Thus, this provision does not provide a blanket allowance for modifications after the useful life.

This section does not apply with respect to modifications that occur within the useful life period, other than to note that many such modifications to the vehicle during the useful life are presumed to violate 42 U.S.C. 7522(a)(3)(A). EPA notes, however, that this is merely a presumption, and would not prohibit modifications during the useful life where the owner clearly has a reasonable technical basis for knowing the modifications would not cause the vehicle to exceed any applicable standard.

(6) Flexibilities

The trailer program that the agencies are proposing incorporates a number of provisions that would have the effect of providing flexibility and easing the compliance burden on trailer manufacturers while maintaining the expected CO_2 and fuel consumption benefits of the program. Among these is the basic approach we used in setting the proposed standards, including the staged phase-in of the standards, which would gradually increase the CO_2 and fuel consumption reductions that manufacturers would need to achieve over time as they also increase their experience with the program. As described in the general certification discussion above (Section IV.F.2), another proposed provision would allow trailer manufacturers to designate broad trailer families that would aggregate several models with similar technologies or performance, thus potentially limiting the number of families and the associated family-level compliance requirements.

In addition to these provisions inherent to the proposed trailer program, the agencies are proposing additional options for certification that we believe would be very valuable to many trailer manufacturers. One of these is the proposed process for component manufacturers to submit test data directly to EPA for review by the agencies in advance of formal certification, allowing a trailer manufacturer to reduce the amount of testing needed to demonstrate compliance or avoid it altogether. See Section IV.F.4 above.

(a) Proposed Averaging Provisions

The agencies are also proposing a limited averaging program as a part of the trailer compliance process for box trailers. This program would be similar to the Phase 1 averaging program for other sectors, but would be narrower in scope to reflect the unique competitive aspects of the trailer market. The trailer manufacturing industry is very competitive, and manufacturers must be highly responsive to their customers' diverse demands. Compared to other industry sectors, this reality can limit the value of the flexibility that averaging could provide to trailer manufacturers, since they can have little control over what kinds of trailer models their customers demand and thus limited ability to manage the mix and volume of different products. In addition, the majority of trailer manufacturers have very few basic trailer models to offer, potentially putting them at a competitive disadvantage to the small number of larger companies that would be in a position to meet market demands that the smaller companies could not. For example, one of the larger, more diverse manufacturers could potentially supply a customer with trailers that had few if any aerodynamic features, while offsetting this part of their business with over-complying trailers that they were able to sell to another customer; many smaller companies with limited product offerings might not be able to compete for those customers.

Although we recognize that there might be potential negative impacts on at least some trailer manufacturers of an averaging program, we believe that there may be overall value to such a program. We propose that full-aero box trailer manufacturers may optionally comply with their standards on average for a trailer family in any given model year. We are not proposing to allow partial-aero box trailers to average. Instead, all trailers in partial-aero families would need to meet the standard for that subcategory. We are proposing to allow a trailer manufacturer to combine partial-aero box trailers with the corresponding full-aero trailer family and reduce the number of certification applications required. We expect this to be particularly beneficial to manufacturers in the early years of the program, when these two trailer categories have identical standards. Although this option should reduce the compliance paperwork, the partial-aero trailers would not be able to adopt enough technologies to meet the full-aero standards in the later years, and manufacturers would have the option of creating a separate family for these trailers. Additionally, we are proposing to allow refrigerated trailers to combine with the dry vans of the same length and meet the dry van standards and to allow short box vans to combine with their long box counterparts to meet the long box standards.

Unlike averaging programs in other sectors, including those in this Phase 2 program, we propose that averaging be limited to a single model year, and manufacturer not be allowed to ''bank'' credits generated from over-compliance in one year for use in a future year. In other words, a manufacturer that produces some trailers in a family that perform better than required by the applicable standard would be allowed to produce a number of trailers that do not meet the standards, provided the average of the trailers it produces in any given model year is at or below the standards. A trailer family performing better than the standard would not be allowed to bank credits for a future model year.[251] However, as a temporary recourse for unexpected challenges in a given model year, we propose that manufacturers be allowed to generate a deficit that would be resolved within the next three model years, and to allow the manufacturer to use credits they generate from over-compliance in subsequent years to address deficits from prior model years. As discussed below, we are not proposing this allowance for non-box trailers or non-aero trailers.

We recognize that at each stage of the program, there may be a small fraction of trailer applications for which the trailer manufacturers cannot easily apply all of the aerodynamic and tire technologies. Thus the proposed dry and refrigerated van standards are designed in the form of family average performance, meaning that each trailer manufacturer would comply on average across the trailer families it produces within each subcategory category (or family). The proposed program would allow a manufacturer, for example, to comply without full adoption of aerodynamic devices across 100 percent of its box trailer production in a trailer family, as long as it also produced a sufficient number of trailers within that family that performed better than the standard, such that the overall production-weighted CO_2 and fuel consumption results of the trailer models in that family complied with the appropriate standard.

In addition to the flexibility created by averaging, the proposed box trailer standards themselves are not predicated on a set adoption rate of any one technology. Manufacturers would be free under the proposed averaging program to choose to apply the appropriate number and type of technologies that met their customers' needs and the level of performance required within a particular trailer family. The proposed rules in general do not mandate inclusion of any particular technology or other means of emission control. The agencies believe that, ordinarily, averaging would create an incentive for manufacturers to promote high-performing technologies for some customers, beyond the requirements for that given year, in order to provide other customers with trailers with fewer aerodynamic technologies.

The agencies also recognize, however, that an averaging program would inherently require a higher degree of data management, record keeping, and reporting than one without averaging. Recognizing that this could impose burdens, especially on small business manufacturers, the agencies are proposing that the averaging provisions be optional; a box trailer manufacturer could choose whether to use averaging

[251] Section IV.F.2 describes the process of identifying trailer families and sub-families based on basic trailer characteristics. Section 1037.710 of the proposed regulations describes the provisions for establishing subfamilies within a trailer family and the Family Emission Limits that would be averaged among the subfamilies.

for any or all of its standard box trailer subcategories (families), or to forego averaging and simply meet the standards with 100 percent of the production within each family. Also, unlike some other regulated motor vehicle sectors, we are not proposing that credits from over-compliance be able to be ''banked'' for use in a later model year, or to be ''traded'' among trailer manufacturers, since they would exacerbate the competitive issues, especially for small manufacturers, as discussed immediately below. However, we are proposing to apply to trailers the provisions of Phase 1 for tractors that allow for the generation of a compliance deficit that could be resolved over several years. Thus, a manufacturer that chose to use averaging, but by the end of the production year found that a trailer family's CO_2 and fuel consumption values did not reach that year's standards, could carry a ''deficit'' that would need to be resolved by the third year following.

The availability of averaging options also has the potential to be a disadvantage to some companies in a competitive market that is highly customer-driven. During the SBREFA process, several manufacturers expressed concern about their ability to manage their credit balances in a highly competitive market. Many believe that they would have little ability to essentially force their customers to purchase the technology, especially if other manufacturers that had credits were able to sell trailers without the technology. We see this as especially problematic for non-box trailers, which are much more likely to be produced by small businesses, and for which customers may have less interest in fuel savings technologies since they are less often used long-haul applications than are box trailers. For these reasons, we are proposing averaging only for dry and refrigerated vans.

The agencies understand that averaging is unfamiliar to many trailer manufacturers and other stakeholders. We have drafted a supplementary document that includes example scenarios to illustrate the concept of averaging for a hypothetical box trailer manufacturer.[252] Example adoption rates are provided for a standard compliance strategy (no averaging) and a strategy using the proposed averaging provisions.

One value of averaging that the agencies have historically cited in several other motor vehicle regulatory programs is that the availability of averaging provisions made it possible for the agencies to propose and enact more stringent standards than would otherwise have been appropriate, recognizing that the expected flexibility of averaging provisions would ease the path to compliance by the more challenged members of the industry. In the case of trailer manufacturers, however, our decisions on the proposed stringency of the standards is essentially independent of the presence or absence of averaging, since, as discussed above, averaging provisions may have relatively less value to manufacturers in this customer-driven industry and we did not speculate about much or how little it might be used.

We also request comment on whether the burden of managing an averaging program could be more trouble than the flexibility is worth. In the event that averaging were not allowed, the agencies would need to require that all trailers meeting specified characteristics meet a minimum stringency level without averaging. If we were to finalize such non-averaging standards, manufacturers would still be allowed to select the appropriate technology package that best achieved their emission performance level, but they would not have the ability to accommodate customers that may request trailers that perform less well on an individual trailer basis.

It is also worth noting that the agencies are not proposing to allow any generation of early credits before MY 2018. It is clear to us that small businesses would be less prepared to begin complying early than larger businesses, and that allowing large manufacturers to generate early credits that could be used later could put small businesses at a competitive disadvantage. It does not appear to us that there would be a sufficient broader programmatic benefit from early credits to justify such an adverse impact on small businesses.

We request comment on this proposed averaging option, including whether the program should allow credit and deficit banking and credit trading, as well as on any other potential provisions that could provide compliance flexibility for trailer manufacturers while achieving the goals of the overall program. Comments supporting averaging, banking, or trading should explain how these provisions would be valuable for trailer manufactures across the industry, including how the provisions would maintain a ''level playing field.''

(b) Proposed SmartWay-Based Certification

Since many manufacturers have some experience with the SmartWay program, the agencies are proposing a gradual transition to the proposed approach that recognizes the parallel SmartWay Technology Program. The agencies expect aerodynamic device manufacturers to continue to submit test data to SmartWay for verification. Device manufacturers that also wish to have their technology available for trailer manufacturers to use in the Phase 2 program could, in parallel, submit their test data to EPA for pre-approval for Phase 2 (see Section IV.F.4). The information obtained by EPA from the device manufacturers would include the technology name, a description of its proper installation procedure, and its corresponding delta C_DA derived from the approved test procedures. Any manufacturers that attained SmartWay verification prior to January 1, 2018 would be eligible to submit their previous data to EPA's Compliance Division for pre-approval, provided their test results come from SmartWay's 2014 test protocols that measure a delta C_DA. The protocols for coastdown, wind tunnel, and computational fluid dynamics analyses result in a C_DA value. Note that SmartWay's 2014 protocols allow SAE J1321 Type 2 track testing, which generates fuel consumption results, not C_DA values. The agencies request comment on whether we should pre-approve devices tested using SAE J1321 and also seek comment on an appropriate means of converting from the fuel consumption results of that test to the delta C_DA values required for trailer compliance.

Beginning on January 1, 2018, EPA would require that device manufacturers that wish to seek approval of new technologies for trailer certification use one of the approved test methods for Phase 2 (*i.e.,* coastdown, constant speed, wind tunnel or CFD) and the test procedures found in 40 CFR 1037.525. Technologies that were pre-approved using SmartWay's 2014 Protocols would maintain their approved status until CY 2021. After January 1, 2021, we are proposing that all pre-approved aerodynamic trailer technologies be tested using the Phase 2 test procedures.

(c) Off-Cycle Technologies

The Phase 1 and proposed Phase 2 programs for tractors include provisions for manufacturers to request the use of off cycle technologies that are not recognized in GEM or were not in common use before MY 2010. In the

[252] Memorandum dated March 2015 on Example Compliance Scenarios for the Proposed GHG Phase 2 Trailer Program. Docket EPA–HQ–OAR–2014–0827.

case of trailers, the agencies are not aware of any technologies that could improve CO_2 and fuel consumption performance that would not be captured in the test protocols as proposed. We are therefore not proposing a process to evaluate off-cycle trailer technologies.

(d) Small Business Regulatory Flexibility Provisions

As a part of our small business obligations under the Regulatory Flexibility Act, EPA and NHTSA have considered additional flexibility provisions aimed at this segment of the trailer manufacturing industry. EPA convened a Small Business Advocacy Review (SBAR) Panel as required by the Small Business Regulatory Enforcement Fairness Act (SBREFA), and much of the information gained and recommendations provided by this process form the basis of the flexibilities proposed.[253] As in previous rulemakings, our justification for including provisions specific to small businesses is that these entities generally have a greater degree of difficulty in complying with the standards compared to other entities. Thus, as discussed below, we are proposing several regulatory flexibility provisions for small trailer manufacturers that we believe would reduce the burden on them while achieving the goals of the program.

We believe that the small business regulatory flexibilities discussed below and in Section XV.C could provide these entities with reduced compliance requirements and/or additional time to accumulate capital internally or to secure capital financing from lenders, and to acquire additional engineering and testing resources.

The agencies designed many of the proposed program elements and flexibility provisions available to all trailer manufacturers with the large fraction of small business trailer manufacturers in mind. We believe the option to choose pre-approved aerodynamic devices would significantly reduce the compliance burden and eliminate the requirement for all manufacturers to perform testing.

As noted above, the small trailer manufacturers raised concerns that their businesses could be harmed by provisions allowing averaging, banking, and trading of emissions and fuel consumption performance, since they would not be able to generate the same volume of credits as large manufacturers. The agencies are proposing not to include banking and trading provisions in any part of the program, and are limiting the option to average to manufacturers of dry and refrigerated box trailers. Since a majority of non-box trailer manufacturers are small businesses, we believe a requirement of specific tire technologies for all non-box trailers would create the most uniformity in requirements among manufacturers and would reduce the compliance burden by eliminating the use of the compliance equation.

In addition to the provisions offered to trailer manufacturers of all sizes, the agencies are proposing or requesting comment on several additional provisions designed specifically to ease compliance burdens on small trailer manufacturers. For all small business trailer manufacturers, the agencies propose a one-year delay in the beginning of implementation of the program, until MY 2019. We believe (subject to consideration of public comment) that this would allow small businesses additional needed lead-time to make the proper staffing adjustments and process changes, and possibly add new infrastructure to meet the requirements. We also request comment about where there may be circumstances in later stages of the program, when the stringency of the standards increase in MY 2021 and 2024, when a similar 1-year delay in implementation could be warranted for small trailer manufacturers.

As mentioned previously, we are proposing to offer averaging provisions for manufacturers of dry and refrigerated box trailers only. We recognize that the small box trailer manufacturers may not be able to fully take advantage of averaging and may be at a competitive disadvantage with larger manufacturers with larger sales volumes and more diverse product lines. We request comment on additional provisions that could ease the potential harm to and/or incentivize small business participation in an averaging program.

The agencies also request comment on provisions for small manufacturers that might face a situation where the technologies needed for compliance are unavailable. This could be a particular concern for small business non-box and non-aero box trailers that require the use of LRR tires and ATI systems. We request that trailer manufacturers as well as tire and aerodynamic technology manufacturers provide information regarding the current projected availability of the technologies that trailer manufacturers can use to meet our proposed standards.

V. Class 2b–8 Vocational Vehicles

A. Summary of Phase 1 Vocational Vehicle Standards

Class 2b–8 vocational vehicles include a wide variety of vehicle types, and serve a wide range of functions. Some examples include service for urban delivery, refuse hauling, utility service, dump, concrete mixing, transit service, shuttle service, school bus, emergency, motor homes, and tow trucks. In the HD Phase 1 Program, the agencies defined Class 2b-8 vocational vehicles as all heavy-duty vehicles that are not included in the Heavy-duty Pickup Truck and Van or the Class 7 and 8 Tractor categories. In effect, the rules classify heavy-duty vehicles that are not a combination tractor or a pickup truck or van as vocational vehicles. Class 2b-8 vocational vehicles and their engines emit approximately 20 percent of the GHG emissions and burn approximately 21 percent of the fuel consumed by today's heavy-duty truck sector.[254]

Most vocational vehicles are produced in a two-stage build process, though some are built from the ''ground up'' by a single entity. In the two-stage process, the first stage sometimes is completed by a chassis manufacturer that also builds its own proprietary components such as engines or transmissions. This is known as a vertically integrated manufacturer. The first stage can also be completed by a chassis manufacturer who procures all components, including the engine and transmission, from separate suppliers. The product completed at the first stage is generally either a stripped chassis, a cowled chassis, or a cab chassis. A stripped chassis may include a steering column, a cowled chassis may include a hood and dashboard, and a cab chassis may include an enclosed driver compartment. Many of the same companies that build Class 7 and 8 tractors also sell vocational chassis in the medium heavy- and heavy heavy-duty weight classes. Similarly, some of the companies that build Class 2b and 3 pickups and vans also sell vocational chassis in the light heavy-duty weight classes.

[253] Additional information regarding the findings and recommendations of the Panel are available in Section XIV, Chapter 11 of the draft RIA, and in the Panel's final report titled ''Final Report of the Small Business Advocacy Review Panel on EPA's Planned Proposed Rule Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles: Phase 2'' (See Docket EPA–HQ–OAR–2014–0827).

[254] *See* Memorandum to the Docket ''Runspecs and Model Inputs for MOVES for HD GHG Phase 2 Emissions Modeling'' Docket Number EPA–HQ–OAR–2014–0827. *See also* EPA's MOVES Web page at *http://www.epa.gov/otaq/models/moves/index.htm.*

The second stage is typically completed by a final stage manufacturer or body builder, which installs the primary load carrying device or other work-related equipment, such as a dump bed, delivery box, or utility boom. There are over 200 final stage manufacturers in the U.S., most of which are small businesses. Even the large final stage manufacturers are specialized, producing a narrow range of vehicle body types. These businesses also tend to be small volume producers. In 2011, the top four producers of truck bodies sold a total of 64,000 units, which is about 31 percent of sales in that year.[255] In that same year, 74 percent of final stage manufacturers produced less than 500 units.

The businesses that act both as the chassis manufacturer and the final stage manufacturer are those that build the vehicles from the ''ground up.'' These entities generally produce custom products that are sold in lower volumes than those produced in large commercial processes. Examples of vehicles produced with this build process would include fire apparatus and transit buses.

The diversity in the vocational vehicle segment can be primarily attributed to the variety of customer needs for specialized vehicle bodies and added equipment, rather than to the chassis. For example, a body builder can build either a Class 6 bucket truck or a Class 6 delivery truck from the same Class 6 chassis. The aerodynamic difference between these two vehicles due to their bodies would lead to different in-use fuel consumption and GHG emissions. However, the baseline fuel consumption and emissions due to the components included in the common chassis (such as the engine, drivetrain, frame, and tires) would be the same between these two types of vehicles.

Owners of vocational vehicles that are upfitted with high-priced bodies that are purpose-built for particular applications tend to keep them longer, on average, than owners of vehicles such as pickups, vans, and tractors, which are traded in broad markets that include many potential secondary markets. The fact that vocational vehicles also generally accumulate far fewer annual miles than tractors further contributes to lengthy trade cycles among owners of these vehicles. To the extent vocational vehicle owners may be similar to owners of tractors in terms of business profiles, they would be more likely to resemble private fleets or owner-operators than for-hire fleets. A 2013 survey conducted by NACFE found that the trade cycle of private tractor fleets ranged from seven to 12 years.[256]

The Phase 1 standards for this vocational vehicle category generally apply at the chassis manufacturer level. For the same reasons given in Phase 1, the agencies propose to apply the Phase 2 vocational vehicle standards at the chassis manufacturer level.[257]

The Phase 1 regulations prohibit the introduction into commerce of any heavy-duty vehicle without a valid certificate or exemption. 40 CFR 1037.620, redesignated as 40 CFR 1037.622 in the proposed rule, allows for a temporary exemption for the chassis manufacturer if it produces the chassis for a secondary manufacturer that holds a certificate. Further discussion of temporary exemptions and possible obligations of secondary manufacturers can be found in Section V. E.

In Phase 1, the agencies adopted two equivalent sets of standards for Class 2b-8 vocational vehicles. For vehicle-level (chassis) emissions, EPA adopted CO_2 standards expressed in grams per ton-mile. For fuel efficiency, NHTSA adopted fuel consumption standards expressed in gallons per 1,000 ton-miles. The Phase 1 engine-based standards vary based on the expected weight class and usage of the vehicle into which the engine will be installed. We adopted Phase 1 vehicle-based standards that vary according to one key attribute, GVWR, based on the same groupings of vehicle weight classes used for the engine standards—light heavy-duty (LHD, Class 2b–5), medium heavy-duty (MHD, Class 6–7), and heavy heavy-duty (HHD, Class 8).

In Phase 1, the agencies defined a special regulatory category called vocational tractor, which generally operate more like vocational vehicles than line haul tractors.[258] As described above in Section III.C.4, under the Phase 1 rules, a vocational tractor is certified under standards for vocational vehicles, not those for tractors. In Phase 2, the agencies propose to retain the vocational tractor definition, and to allow vocational tractors to certify over any of the proposed vocational vehicle duty cycles, following the same decision-tree as other vocational chassis. Vocational tractors would continue to satisfy the proposed engine standard and vocational vehicle GEM-based standard, rather than the proposed tractor standard.

Manufacturers are required to use GEM to determine compliance with the Phase 1 vocational vehicle standards, where the primary vocational vehicle manufacturer-generated input is the measure of tire rolling resistance. The GEM assumes the use of a typical representative, compliant engine in the simulation, resulting in one overall value for CO_2 emissions and one for fuel consumption. The manufacturers of engines intended for use in vocational vehicles are subject to separate Phase 1 engine-based standards. Manufacturers also may demonstrate compliance with the CO_2 standards in whole or in part using credits reflecting CO_2 reductions resulting from technologies not reflected in the GEM testing regime. See 40 CFR 1037.610.

In Phase 1, EPA and NHTSA also adopted provisions designed to give manufacturers a degree of flexibility in complying with the standards. Most significantly, we adopted an ABT program to allow manufacturers within the same averaging set to comply on average. See 40 CFR part 1037, subpart H. These provisions enabled the agencies to adopt overall standards that are more stringent than we could have considered with a less flexible program.[259]

B. Proposed Phase 2 Standards for Vocational Vehicles

The agencies have held dozens of meetings with manufacturers, suppliers, non-governmental organizations (NGOs), and other stakeholders to identify and understand the opportunities and challenges involved with regulating vocational vehicles. These meetings have helped us to better understand the performance demands of the customers, the fuel-saving and GHG reducing technologies that are being investigated, as well as some challenges that are being encountered. In addition, we updated our industry characterization to better understand the vocational vehicle manufacturing process, including the component suppliers and body builders.[260] We believe these information exchanges have enabled us to develop this proposal with an appropriate balance of

[255] Specialty Transportation.net, 2012. Truck Body Manufacturing in North America.

[256] See 2013 ICCT Barriers Report at Note 241, above.

[257] See 76 FR 57120.

[258] See EPA's regulation at 40 CFR 1037.630 and NHTSA's regulation at 49 CFR 523.2.

[259] As noted earlier, NHTSA notes that it has greater flexibility in the HD program to include consideration of credits and other flexibilities in determining appropriate and feasible levels of stringency than it does in the light-duty CAFE program. *Cf.* 49 U.S.C. 32902(h), which applies to light-duty CAFE but not to heavy-duty fuel efficiency under 49 U.S.C. 32902(k).

[260] September 2013, Heavy Duty Vocational Vehicle Industry Characterization, EPA Contract No. EP–C–12–011.

reasonably achievable goals and a reasonably small risk of unintended consequences.

(1) Proposed Subcategories and Test Cycles

The proposed Phase 2 vocational vehicle standards are based on the performance of a wider array of control technologies than the Phase 1 rules. In particular, the agencies are proposing to recognize detailed characteristics of powertrains and drivelines in the proposed Phase 2 vocational vehicle standards. As described below, driveline improvements present a significant opportunity for reducing fuel consumption and CO_2 emissions from vocational vehicles. However, there is no single package of driveline technologies that would be equally suitable for the majority of vocational vehicles, because there is an extremely broad range of driveline configurations available in the market. This is due in part to the variety of build processes, ranging from a purpose built custom chassis to a commercial chassis that may be intended as a multi-purpose stock vehicle. Further, the wide range of applications and driving patterns of these vehicles leads manufacturers to offer a variety of drivelines, as each performs differently in use. For example, depending on whether the transmission has an overdrive gear, drive axle ratios for Class 7 and 8 tractors can be found in the range of 2.5:1 to 4.1:1. By contrast, across all types of vocational vehicles, drive axle ratios can be as low as 3.1:1 (delivery vehicle) and as high as 9.8:1 (transit bus).[261] Other components of the driveline also have a broader range of product in vocational vehicles than in tractors, including transmission gears, tire sizes, and engine speeds. Each of these design features affects the GHG emission rate and fuel consumption of the vehicle. It therefore is reasonable to define more than one baseline configuration of vocational vehicle, to encompass a range of drivelines and recognize that the agencies cannot use a one-size-fits-all approach. A detailed list of the technologies the agencies project could be adopted to meet the proposed vocational vehicle standards is described in Section V.C, and in the draft RIA Chapter 2. The agencies have determined that these technologies perform differently depending on the drivelines and driving patterns, further supporting the need to subcategorize this segment.

For these reasons, the agencies are proposing to create additional subcategories of vocational vehicles in Phase 2. By creating additional subcategories we would essentially be setting separate baselines and separate numerical performance standards for different groups of vocational vehicle chassis over different test cycles. This would enable the technologies that perform best at highway speeds and those that perform best in urban driving to each to be fully recognized over appropriate test cycles, while avoiding the unintended consequence of forcing vocational vehicles that are designed to serve in a wide variety of applications to be measured against a single baseline. The attributes we believe could define these chassis groups are described below.

The agencies are proposing to split groups of chassis into subcategories based generally on vehicle use patterns in which the CO_2 emissions and fuel consumption standards vary as a consequence. Compliance with these standards would be demonstrated through test cycles reflecting these use patterns, to best assure that actual in-use benefits occur. An ideal test cycle is one in which the performance improvements achieved by the adopted technologies are recognized over the cycle. As described in Section V.C and in the draft RIA Chapter 2.9, the agencies have found that most of the technologies considered do perform differently under different driving conditions. For example, the effectiveness of lower tire rolling resistance is different depending on the degree of highway or transient driving, but the differences are very small compared to the difference in effectiveness for a hybrid drivetrain under different driving conditions. The agencies have found that the measurable changes in performance of a majority of the technologies are significant enough to merit creation of different subcategories with different test cycles.

Idle reduction technology is one type of technology that is particularly duty-cycle dependent. The composite test cycle for vocational vehicles in Phase 1 includes a 42 percent weighting on the ARB Transient test cycle, which comprises nearly 17 percent of idle time. However, no single idle event in this test cycle is longer than 36 seconds, which may not be enough time to adequately recognize the benefits of some idle reduction technologies.[262] For Phase 2, the agencies propose to recognize this important fuel saving technology by evaluating workday idle reduction technologies through a new idle-only cycle as described in the draft RIA Chapter 3.

The agencies are proposing three different composite test cycles for vocational vehicles in Phase 2: Regional, Multi-Purpose, and Urban. The agencies believe these three cycles balance the competing pressures to recognize the varying performance of technologies, serve the varying needs of customers, and maintain reasonable regulatory simplicity. Table V–1 below presents the nine proposed subcategories of vocational vehicles: Three weight class groupings, each with three composite duty cycles. Each of these proposed composite duty cycles has a different weighting of the new idle cycle, the highway cruise cycles, and the ARB Transient cycle, as shown in Table V–2. The CALSTART HD Truck Fuel Economy Task Group met in June 2013 to discuss vocational vehicle segmentation, and suggested an approach very similar to this. The task group generally supported a limited number of duty cycles that would be sufficient to cover the basic applications while allowing new technology to demonstrate its worth. They recognized that a few meaningful duty cycles could ''bound'' how vocational vehicles are generally used, while recognizing that this approach would not perfectly match how every vocational vehicle is actually used. Their recommendations included three vocational vehicle duty-cycle-based subcategories: Urban, Regional, and Work Site. A detailed discussion of the CALSTART recommendations, as well as reasoning why the agencies selected the proposed composite cycle weightings can be found in the draft RIA Chapter 2. Continuing the averaging scheme from Phase 1, each manufacturer would be able to average within each vehicle weight class.

[261] See Dana Spicer Drive Axle Application Guidelines, available at *http://www.dana.com/wps/wcm/connect/133007004bd8422b9ea8be14e7b6dae0/DEXT-daag2012_0712_DriveAxlesAppGuide_LR.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=133007004bd8422b9ea8be14e7b6dae0*. See also ZF Driveline and Chassis Technology brochure, available at *http://www.zf.com/media/media/en/document/corporate_2/downloads_1/flyer_and_brochures/bus_driveline_technology_flyer/Busbroschuere_12_DE_final.pdf*

[262] However, as noted above, emission improvements due to workday idle technology can be recognized under Phase 1 as an innovative credit under 40 CFR 1037.610 and 49 CFR 535.7.

TABLE V–1—PROPOSED REGULATORY SUBCATEGORIES FOR VOCATIONAL VEHICLES

Weight class	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
Duty Cycle	Regional Multi-Purpose Urban	Regional Multi-Purpose Urban	Regional. Multi-Purpose. Urban.

TABLE V–2—PROPOSED COMPOSITE TEST CYCLE WEIGHTINGS (IN PERCENT) FOR VOCATIONAL VEHICLES

	ARB transient	55 mph cruise with road grade [a]	65 mph cruise with road grade [a]	Idle
Regional	50	28	22	10
Multi-Purpose	82	15	3	15
Urban	94	6	0	20

Note:
[a] As described in Section III.E.2.b, the agencies are proposing to add road grade to the highway cruise test cycles.

The agencies are proposing criteria for determining the applicability of these subcategories. This is not as straightforward an exercise as with tractors, where attributes such as cab type are obvious physical properties that indicate reasonably well how a vehicle is intended to be used. The agencies have identified the final drive ratio of a vocational vehicle as a possible attribute that may indicate how the vehicle is intended to be used. As described in Section V.E.(1)(d), we expect that most vocational chassis could be assigned to a duty cycle by estimating the percent of maximum engine test speed that is achieved over highway cruise cycles, by use of an equation that relates engine speed to vehicle speed. To simplify this assignment process, the agencies propose that a vocational chassis would be presumed to certify using the Multi-Purpose duty cycle unless some criteria were met that indicated either the Regional or Urban cycle would be more appropriate. Those criteria could include the objective calculation described in Section V.E., or a mix of physical attributes and knowledge of intended use. The agencies are also proposing that chassis manufacturers would be able to request a different duty cycle.

We understand that even within certain vocational vehicle types, vehicle use varies significantly. By employing the agencies' recommended assignment process, it is our expectation that a delivery truck and a dump truck could both be certified over the same duty cycle while still yielding accurate technology effectiveness, if they had similar chassis and driveline characteristics. Further, while intended service class may help a manufacturer decide how to classify some vehicles, we do not believe that intended service class would be a sufficient indicator by itself. An example of this is the refuse service class. A neighborhood collection refuse truck would not need to be assigned to the same subcategory as a roll-off refuse straight/dump truck that makes daily highway trips to a landfill.

The agencies request comment on the method for assigning vocational chassis to regulatory subcategories. We believe the proposed approach is aligned with the objective to allow manufacturers to certify their chassis over appropriate duty cycles, while maintaining the ability of the market to offer a variety of products to meet customer demand.

(2) Alternative Approach to Subcategorization

The U.S. Department of Energy and EPA are partnering to support a project aimed at evaluating, refining and/or developing duty cycles for tractors and vocational vehicles to be used in the certification of heavy-duty vehicles to GHG emission standards. This project is underway at the National Renewable Energy Laboratory (NREL) and includes a task to develop alternative subcategorization options for vocational vehicles, along with new drive cycles and/or cycle composite weightings. NREL is continuing to collate available vehicle activity data and vehicle characteristics, and the public is invited to submit information to the docket in support of this work to identify possible alternative GEM test cycles and segmentation options for vocational vehicles. Preliminary work under this project indicates that two or three test cycles may adequately represent most vocational vehicles. Depending on how many distinct vehicle driving patterns can be identified with correlation to vehicle attributes, the agencies may finalize a vocational subcategorization approach that includes as few as two or as many as five composite GEM duty cycles. It is also possible that some test cycles may not apply to all subcategories. It is further possible that the approach to assignment of vocational chassis to subcategories in the final rules may be based on different attributes than those proposed, including different engine and driveline characteristics and different indicators of vehicle purpose. Preliminary work from NREL indicates that in-use drive cycles may include more idle operation for all types of vocational vehicles than is represented by the currently proposed GEM test cycles. Depending on comments and additional information received during the comment period, it may be within the agencies' discretion to adopt one or more alternative vocational vehicle test cycles, or re-weight the current test cycles, to better represent real world driving and better reflect performance of the technology packages.

(3) Proposed GHG and Fuel Consumption Standards for Vocational Vehicles

EPA is proposing CO_2 standards and NHTSA is proposing fuel consumption standards for manufacturers of chassis for new vocational vehicles. As described in Sections II.C.1 and II.D.1 above, the agencies are proposing test procedures so that engine performance would be evaluated within the GEM simulation tool. These test procedures include corrections for the test fuel, enabling vocational vehicles to be certified with many different types of CI and SI engines. In addition, EPA is proposing to establish HFC leakage standards for air conditioning systems in vocational vehicles, as described below and in the draft RIA Chapters 2 and 5.

This section describes the standards and implementation dates that the agencies are proposing for the nine subcategories of vocational vehicles. The agencies have performed a technology analysis to determine the level of standards that we believe would be available at reasonable cost, and would be cost-effective, technologically feasible, and appropriate in the lead time provided. More details of this analysis are described in the draft RIA Chapter 2. This analysis considered the following for each of the proposed regulatory subcategories:

- The level of technology that is incorporated in current new vehicles,
- forecasts of manufacturers' product redesign schedules,
- the available data on CO_2 emissions and fuel consumption for these vehicles,
- technologies that would reduce CO_2 emissions and fuel consumption and that are judged to be feasible and appropriate for these vehicles through the 2027 model year,
- the effectiveness and cost of these technologies,
- a projection of the technologically feasible application rates of these technologies, in this time frame, and
- projections of future U.S. sales for different types of vehicles and engines.

The proposal described here and throughout the rulemaking documents is the preferred alternative, referred to as Alternative 3 in Section X and the draft RIA Chapter 11. However, the agencies are seriously considering another alternative for all segments, including vocational vehicles, referred to as Alternative 4. The agencies believe that Alternative 4 has the potential to be the maximum feasible and reasonable alternative. However, based on the evidence currently before the agencies, EPA and NHTSA have outstanding questions regarding relative risks and benefits of Alternative 4 due to the time frame envisioned by that alternative. Alternative 4 is predicated on the same general market adoption rates of the same technologies as the proposal, but would provide three years less lead time than the proposal. Details of Alternative 4 are presented in Section V.D, Section X, and in the draft RIA Chapter 11.

The agencies seek comment on the feasibility of Alternative 4 for vocational vehicles, including empirical data on its appropriateness, cost-effectiveness, and technological feasibility. It would be helpful if comments addressed these issues separately for each type of technology.

Additional information and feedback could further inform our assumptions and, by extension, our analysis of feasibility. The agencies believe it is possible that it could be within the agencies' discretion to determine in the final rules that Alternative 4 could be maximum feasible and appropriate under CAA section 202(a)(1) and (2). If the agencies receive relevant information supporting the feasibility of Alternative 4, or regarding technology pathways different than those in Alternatives 3 and 4, the agencies may consider establishing final fuel consumption and GHG emission standards at levels that provide more overall reductions than what we are proposing if we deem them to be maximum feasible and reasonable for NHTSA and EPA, respectively.

(a) Proposed Fuel Consumption and CO_2 Standards

The agencies are proposing standards that would phase in over a period of seven years, beginning in the 2021 model year, consistent with the requirement in EISA that NHTSA's standards provide four full model years of regulatory lead time and three full model years of regulatory stability, and provide sufficient time ''to permit the development and application of the requisite technology'' for purposes of CAA section 202(a)(2). The proposed Phase 2 program would progress in three-year stages with an intermediate set of standards in MY 2024 and would continue to reduce fuel consumption and CO_2 emissions well beyond the full implementation year of MY 2027. The agencies have identified a technology path for each of these levels of improvement, as described below.

Combining engine and vehicle technologies, vocational vehicles powered by CI engines would be projected to achieve improvements of 16 percent in MY 2027 over the MY 2017 baseline, as described below and in the draft RIA Chapter 2. The agencies project up to 13 percent improvement in fuel consumption and CO_2 emissions in MY 2027 from SI-powered vocational vehicles, as shown in Table V–3. The incremental Phase 2 vocational vehicle standards would ensure steady progress toward the MY 2027 standards, with improvements in MY 2021 of up to seven percent and improvements in MY 2024 of up to 11 percent over the MY 2017 baseline vehicles, as shown in Table V–3.

The agencies' analyses, as discussed in this preamble and in the draft RIA Chapter 2, show that the proposed standards would be appropriate under each agency's respective statutory authority.

TABLE V–3—PROJECTED VOCATIONAL VEHICLE CO_2 AND FUEL USE REDUCTIONS (IN PERCENT) FROM 2017 BASELINE

Model year	Engine type	Heavy heavy-duty class 8	Medium heavy-duty class 6–7	Light heavy-duty class 2b–5
2021	CI Engine	7	7	6
	SI Engine	5	5	4
2024	CI Engine	11	11	10
	SI Engine	7	7	7
2027	CI Engine	16	16	16
	SI Engine	12	13	12

Based on our analysis and research, the agencies believe that the improvements in vocational vehicle fuel consumption and CO_2 emissions can be achieved through deployment and utilization of a greater set of technologies than formed the technology basis for the Phase 1 standards. In developing the proposed standards, the agencies have evaluated the current levels of fuel consumption and emissions, the kinds of technologies that could be utilized by manufacturers to reduce fuel consumption and emissions, the associated lead time, the associated costs for the industry, fuel savings for the owner/operator, and the magnitude of the CO_2 reductions and fuel savings that may be achieved. After examining the possibilities of vehicle improvements, the agencies are basing the proposed standards on the performance of workday idle reduction technologies, improved transmissions including hybrid powertrains, axle technologies, weight reduction, and further tire rolling resistance improvements. The EPA-only air conditioning standard is based on leakage improvements.

The agencies' evaluation indicates that some of the above vehicle technologies are commercially available today, though often in limited volumes. Other technologies would need additional time for development. Those that we believe are available today and may be adopted to a limited extent in some vehicles include improved tire rolling resistance, weight reduction, some types of conventional transmission improvements, neutral idle, and air conditioning leakage improvements. However, EPA is not proposing standards predicated on performance of these technologies until MY 2021.[263] The agencies consider any potential benefits that could be achieved by implementing rules requiring some technologies on vocational vehicles earlier than MY 2021 to be outweighed by several disadvantages. For one, manufacturers would need lead time to develop compliance tracking tools. Also, if the Phase 2 vocational vehicle standards began in a different year than the tractor standards, this could create unnecessary added complexity, and could strongly detract from the fuel savings and GHG emission reductions that could otherwise be achieved. Therefore we anticipate that the Phase 1 standards will continue to apply in model years 2018 to 2020.

Vehicle technologies that we believe will become available in the near term include improved axle lubrication and 6x2 axles. Vehicle technologies that we understand would benefit from even more development time include stop-start idle reduction and hybrid powertrains. The agencies have analyzed the technological feasibility of achieving the fuel consumption and CO_2 standards, based on projections of what actions manufacturers would be expected to take to reduce fuel consumption and emissions to achieve the standards, and believe that the standards would be technologically feasible throughout the regulatory useful life of the program. EPA and NHTSA estimated vehicle package costs are found in Section V.C.(2).

Table V–4 and Table V–5 present EPA's proposed CO_2 standards and NHTSA's proposed fuel consumption standards, respectively, for chassis manufacturers of Class 2b through Class 8 vocational vehicles for the beginning model year of the program, MY 2021. As in Phase 1, the standards would be in the form of the mass of emissions, or gallons of fuel, associated with carrying a ton of cargo over a fixed distance. The EPA standards would be measured in units of grams CO_2 per ton-mile and the NHTSA standards would be in gallons of fuel per 1,000 ton-miles. With the mass of freight in the denominator of this term, the program is designed to measure improved efficiency in terms of freight efficiency. As in Phase 1, the Phase 2 program would assign a fixed default payload in GEM for each vehicle weight class group (heavy heavy-duty, medium heavy-duty, and light heavy-duty). Even though this simplification does not allow individual vehicle freight efficiencies to be recognized, the general capacity for larger vehicles to carry more payload is represented in the numerical values of the proposed standards for each weight class group.

EPA's proposed vocational vehicle CO_2 standards and NHTSA's proposed fuel consumption standards for the MY 2024 stage of the program are presented in Table V–6 and Table V–7, respectively. These reflect broader adoption rates of vehicle technologies already considered in the technology basis for the MY 2021 standards. The standards for vehicles powered by CI engines also reflect that in MY 2024, the separate engine standard would be more stringent, so the vehicle standard keeps pace with the engine standard.

EPA's proposed vocational vehicle CO_2 standards and NHTSA's proposed fuel consumption standards for the full implementation year of MY 2027 are presented in Table V–8 and Table V–9, respectively. These reflect even greater adoption rates of the same vehicle technologies considered in the basis for the previous stages of the Phase 2 standards. The proposed MY 2027 standards for vocational vehicles powered by CI engines reflect additional engine technologies consistent with those on which the separate proposed MY 2027 CI engine standard is based. The proposed MY 2027 standards for vocational vehicles powered by SI engines reflect improvements due to additional engine friction reduction technology, which is not among the technologies on which the separate SI engine standard is based.

The proposed standards are based on highway cruise cycles that include road grade, to better reflect real world driving and to help recognize engine and driveline technologies. See Section III.E. The agencies have evaluated some alternate road grade profiles, including several recommended by NREL and two developed independently by the agencies, and have prepared possible alternative vocational vehicle standards based on these profiles. The agencies request comment on this analysis, which is available in a memorandum to the docket.[264]

As described in Section I, the agencies are proposing to continue the Phase 1 approach to averaging, banking and trading (ABT), allowing ABT within vehicle weight classes. For Phase 2, continuing this approach means allowing averaging between CI-powered vehicles and SI-powered vehicles that belong to the same weight class group and have the same regulatory useful life.

TABLE V–4—PROPOSED EPA CO_2 STANDARDS FOR MY 2021 CLASS 2b–8 VOCATIONAL VEHICLES

Duty cycle	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
EPA Standard for Vehicle with CI Engine Effective MY 2021 (gram CO_2/ton-mile)			
Urban	296	188	198
Multi-Purpose	305	190	200
Regional	318	186	189
EPA Standard for Vehicle with SI Engine Effective MY 2021 (gram CO_2/ton-mile)			
Urban	320	203	214

[263] NHTSA is unable to adopt mandatory amended standards in those model years since there would be less than the statutorily-prescribed amount of lead time available. 49 U.S.C. 32902(k)(3)(A).

[264] See Memorandum dated May 2015 on Possible Tractor, Trailer, and Vocational Vehicle Standards Derived from Alternative Road Grade Profiles.

TABLE V–4—PROPOSED EPA CO_2 STANDARDS FOR MY 2021 CLASS 2b–8 VOCATIONAL VEHICLES—Continued

Duty cycle	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
Multi-Purpose	329	205	216
Regional	343	201	204

TABLE V–5—PROPOSED NHTSA FUEL CONSUMPTION STANDARDS FOR MY 2021 CLASS 2b–8 VOCATIONAL VEHICLES

Duty cycle	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
NHTSA Standard for Vehicle with CI Engine Effective MY 2021 (Fuel Consumption gallon per 1,000 ton-mile)			
Urban	29.0766	18.4676	19.4499
Multi-Purpose	29.9607	18.6640	19.6464
Regional	31.2377	18.2711	18.5658
NHTSA Standard for Vehicle with SI Engine Effective MY 2021 (Fuel Consumption gallon per 1,000 ton-mile)			
Urban	36.0077	22.8424	24.0801
Multi-Purpose	37.0204	23.0674	24.3052
Regional	38.5957	22.6173	22.9549

TABLE V–6—PROPOSED EPA CO_2 STANDARDS FOR MY 2024 CLASS 2b–8 VOCATIONAL VEHICLES

Duty cycle	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
EPA Standard for Vehicle with CI Engine Effective MY 2024 (gram CO_2/ton-mile)			
Urban	284	179	190
Multi-Purpose	292	181	192
Regional	304	178	182
EPA Standard for Vehicle with SI Engine Effective MY 2024 (gram CO_2/ton-mile)			
Urban	312	197	208
Multi-Purpose	321	199	210
Regional	334	196	199

TABLE V–7—PROPOSED NHTSA FUEL CONSUMPTION STANDARDS FOR MY 2024 CLASS 2b–8 VOCATIONAL VEHICLES

Duty cycle	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
NHTSA Standard for Vehicle with CI Engine Effective MY 2024 (Fuel Consumption gallon per 1,000 ton-mile)			
Urban	27.8978	17.5835	18.6640
Multi-Purpose	28.6837	17.7800	18.8605
Regional	29.8625	17.4853	17.8782
NHTSA Standard for Vehicle with SI Engine Effective MY 2024 (Fuel Consumption gallon per 1,000 ton-mile)			
Urban	35.1075	22.1672	23.4050
Multi-Purpose	36.1202	22.3923	23.6300
Regional	37.5830	22.0547	22.3923

TABLE V–8—PROPOSED EPA CO_2 STANDARDS FOR MY 2027 CLASS 2b–8 VOCATIONAL VEHICLES

Duty cycle	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
EPA Standard for Vehicle with CI Engine Effective MY 2027 (gram CO_2/ton-mile)			
Urban	272	172	182
Multi-Purpose	280	174	183

TABLE V–8—PROPOSED EPA CO_2 STANDARDS FOR MY 2027 CLASS 2b–8 VOCATIONAL VEHICLES—Continued

Duty cycle	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
Regional	292	170	174
EPA Standard for Vehicle with SI Engine Effective MY 2027 (gram CO_2/ton-mile)			
Urban	299	189	196
Multi-Purpose	308	191	198
Regional	321	187	188

TABLE V–9—PROPOSED NHTSA FUEL CONSUMPTION STANDARDS FOR MY 2027 CLASS 2b–8 VOCATIONAL VEHICLES

Duty cycle	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
NHTSA Standard for Vehicle with CI Engine Effective MY 2027 (Fuel Consumption gallon per 1,000 ton-mile)			
Urban	26.7191	16.8959	17.8782
Multi-Purpose	27.5049	17.0923	17.9764
Regional	28.6837	16.6994	17.0923
NHTSA Standard for Vehicle with SI Engine Effective MY 2027 (Fuel Consumption gallon per 1,000 ton-mile)			
Urban	33.6446	21.2670	22.0547
Multi-Purpose	34.6574	21.4921	22.2797
Regional	36.1202	21.0420	21.1545

As with the other regulatory categories of heavy-duty vehicles, NHTSA and EPA are are proposing standards that apply to Class 2b–8 vocational vehicles at the time of production, and EPA is proposing standards for a specified period of time in use (*e.g.,* throughout the regulatory useful life of the vehicle). The derivation of the standards for these vehicles, as well as details about the proposed provisions for certification and implementation of these standards, are discussed in more detail later in this notice and in the draft RIA.

(b) Proposed HFC Leakage Standards

The Phase 1 GHG standards do not include standards to control direct HFC emissions from air conditioning systems on vocational vehicles. EPA deferred such standards due to ''the complexity in the build process and the potential for different entities besides the chassis manufacturer to be involved in the air conditioning system production and installation''. See 76 FR 57194. During our stakeholder outreach conducted for Phase 2, we learned that the majority of vocational vehicles are sold as cab-completes with the dashboard-mounted air conditioning systems installed by the chassis manufacturer. For those vehicles that have A/C systems installed by a second stage manufacturer, EPA is proposing revisions to our regulations that would resolve the issues identified in Phase 1, in what we believe is a practical and feasible manner, as described below in Section V.E.

For the above reasons, in Phase 2, EPA now believes that it is reasonable to propose A/C refrigerant leakage standards for Class 2b–8 vocational vehicles, beginning with the 2021 model year. Chassis sold as cab-completes typically have air conditioning systems installed by the chassis manufacturer. For these configurations, the process for certifying that low leakage components are used would follow the system in place currently for comparable systems in tractors. In the case where a chassis manufacturer would rely on a second stage manufacturer to install a compliant air conditioning system, the chassis manufacturer must follow the proposed delegated assembly provisions described below in Section V.E.

(4) Proposed Exemptions and Exclusions

(a) Proposed Standards for Emergency Vehicles

Emergency vehicles are covered by the Phase 1 program at the same level of stringency as any other vocational vehicle. In discussions with representatives of the Fire Apparatus Manufacturers Association, the agencies have learned that chassis manufacturers of fire apparatus are currently able to obtain compliant engines and tires with the coefficient of rolling resistance allowing compliance with the Phase 1 standards. The agencies are proposing in Phase 2 to allow emergency vehicles to meet less stringent standards than other vocational vehicles. There are two reasons for doing so. First, as the level of complexity of Phase 2 would increase with the need for additional technologies aimed to improve driveline efficiency, the compliance burden would be disproportionately high for a company that manufactures small volumes of specialized chassis. The ability of such a company to benefit from averaging would be limited, as would be the ability to spread compliance costs across many vehicles. The second and more important reason is that emergency vehicles, which are necessarily built for high levels of performance and reliability, would likely sacrifice some levels of function to attain the proposed Phase 2 standards. For example, vehicles with large engines, high-torque powertrains, and tires designed with deep tread would likely be deficit-producing vehicles if manufacturers needed to certify an emergency vehicle family to the primary proposed standards.

In the MY 2017–2025 light-duty rule, the agencies adopted an exclusion for emergency and police vehicles from GHG and fuel economy standards.[265] As described in that rule, the unique features of purpose-built emergency vehicles, such as high rolling resistance

[265] See 77 FR 62653, October 12, 2012.

tires, reinforced suspensions, and special calibrations of engines and transmissions, have the effect of raising their GHG emissions. The agencies determined in that rule that an exemption was appropriate because the technological feasibility issues for emergency vehicles went beyond those of other high-performance vehicles, and vehicles with these performance characteristics must continue to be made available in the market. The agencies do not believe that non-emergency vocational vehicles are designed for the severe duty cycles that are experienced by emergency vehicles, and therefore do not face the same potential constraints in terms of vehicle design and the application of technology.

In conducting an independent technological feasibility assessment for heavy-duty emergency vehicles, the agencies believe that some GHG and fuel saving technologies could reasonably be applied without compromising vehicle utility. However, these vehicles are designed, built, and operated so differently than other vocational vehicles that we believe keeping them in the same averaging sets as other vocational vehicles in Phase 2 would not be appropriate and thus a separate standard (evaluated from a baseline specific to these vehicles) is warranted.

Our feasibility analysis and the available tire data indicate that emergency vehicle manufacturers can reasonably continue to apply tires with the Phase 1 level tire CRR performance, in the Phase 2 program. We have also learned that a variety of vehicle-level technologies are being developed specifically for emergency vehicles, to maintain on-board electronics without excessive idling. Modern fire apparatus and ambulances typically have multiple computers and other electronic devices on-board, each of which requires power and continues to draw electricity when the vehicle is parked and the crew is responding to an emergency, which could take several hours. Most on-board batteries and alternators are not capable of sustaining these power demands for any length of time, so emergency vehicles must either operate in a high-idle mode or adopt one of several possible technologies that can assist with electrical load management. Some of these technologies can enable an emergency vehicle to shut down the main engine and drastically reduce idle emissions.[266] NHTSA and EPA have not based the proposed emergency vehicle standards on use of idle reduction technologies because we do not believe the regular neutral idle and stop-start technologies we project for other vocational vehicles could apply equally to emergency vehicles, and we do not have enough information about this subset of idle reduction technologies that is designed for extended electrical load management to either estimate an effectiveness value or determine an appropriate market adoption rate. The agencies request comment on whether we should include any market adoption rate of idle reduction technologies for emergency vehicles, as part of the basis for the Phase 2 emergency vocational vehicle standard.

To address both the technical feasibility and the compliance burden, the agencies are proposing less stringent standards that also have a simplified compliance method. Because the potential trade-offs between performance and fuel efficiency apply equally to any emergency vehicle manufacturer, the agencies propose that these less stringent standards would apply for commercial chassis manufacturers of emergency vehicles, as well as for custom chassis manufacturers. The standard for vehicles identified at the time of certification as being intended for emergency service would be predicated solely on the continued use of lower rolling resistance tires, at the Phase 2 baseline level (*i.e.* compliant with Phase 1).[267]

With respect to standards for engines used in these emergency vehicles, based on what we have learned from discussions with engine manufacturers, we understand that engines designed for heavy-duty emergency vehicles are generally higher-emitting than other engines. However, if we maintain a separate engine standard and regulatory flexibility such as ABT, fire apparatus manufacturers would be able to obtain engines that, on average, meet the proposed Phase 2 engine standards. The agencies further recognize that the proposed engine map inputs to GEM in the primary program would pose a difficulty for emergency vehicle manufacturers. If we required engine-specific inputs then these manufacturers would have to apply extra vehicle technologies to compensate for the necessary but higher-emitting engine. The agencies are therefore not proposing to recognize engine performance as part of the vehicle standard for emergency vehicles. Manufacturers of these vehicles would be expected to install an engine that is certified to the applicable separate Phase 2 engine standard. However, under the simplified compliance method we are proposing, emergency vehicle manufacturers would not follow the otherwise applicable Phase 2 proposed approach of entering an engine map in GEM. Instead a Phase 1 style GEM interface would be made available, where an EPA default engine specified by rule would be simulated in GEM. The agencies request comments on the merits of using an equation-based compliance approach for emergency vehicle manufacturers, similar to the approach proposed for trailer manufacturers and described in Section IV.F.

This approach is consistent with the approach recommended by the Small Business Advocacy Review Panel, which believed it would be feasible for small emergency vehicle manufacturers to install a Phase 2-compliant engine, but recommended a simplified certification approach to reduce the number of required GEM inputs. Consistent with the recommendations of this panel, the agencies are asking for comments on whether there would be enough fuel consumption and CO_2 emissions benefits achieved by use of LRR tires in emergency vehicles to justify requiring small business emergency chassis manufacturers to adopt them.

We expect some commercial chassis manufacturers that serve the emergency vehicle market may have the ability to meet the proposed Phase 2 standards of our primary program when including emergency vehicles in their averaging sets. Even so, we are proposing that they have the option to comply with the less stringent standards, because there are fewer opportunities to improve fuel efficiency on emergency vehicles, which (as noted) are designed for high levels of performance and severe duty. The agencies expect that this compliance path would be most needed by custom chassis manufacturers who serve the emergency vehicle market. Custom chassis manufacturers typically offer a narrow range of products with low sales volumes. Therefore, fleet averaging would provide a lower level of compliance flexibility, and there would be less opportunity to spread the costs of developing advanced technologies across a large number of vehicles. Further, many custom chassis manufacturers do not qualify as small entities under the SBA regulations. Thus, the agencies believe that existence of program-wide ABT does not vitiate

[266] *See* ''How to solar power a fire truck or ambulance,'' available at *http://www.firerescue1.com/fire-products/apparatus-accessories/articles/1934440-How-to-solar-power-a-fire-truck-or-ambulance/*, accessed November 2014.

[267] See 40 CFR 86.1803–01 for the applicable definition of emergency vehicle.

the need to propose alternative, less stringent standards for emergency vehicles.

Table V–10 below presents the proposed numerical standards to which an emergency vehicle chassis would be certified under this provision. Emergency vehicles certified to these proposed emergency vehicle standards would be ineligible to generate credits. The proposed standards shown below were derived by building a model of three baseline vehicles (LHD, MHD, HHD) using attributes similar to those developed for the primary program as assigned to the Urban drive cycle subcategories. By modeling a 2021-compliant engine and tires with CRR of 7.7, the MY 2021 standards were derived using GEM. Details of these configurations are provided in the draft RIA Chapter 2.

TABLE V–10—PROPOSED STANDARDS FOR CLASS 2b–8 EMERGENCY VEHICLES FOR MY 2021 AND LATER

Implementation year	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
Proposed EPA Emergency Vehicle Standard (gram CO_2/ton-mile)			
MY2021	312	195	215
Proposed NHTSA Emergency Vehicle Standard (Fuel Consumption gallon per 1,000 ton-mile)			
MY2021	30.6483	19.1552	21.1198

The agencies have estimated the costs of vocational vehicle technology packages, as presented below in Table V–20 to Table V–22. The technologies on which the proposed emergency vehicle standards are based include engines, LRR tires, and leak-tight air conditioning systems. Using the estimated costs of those technologies as presented, the agencies estimate that the average cost for a heavy heavy-duty or medium-heavy-duty emergency vehicle to meet the proposed emergency vehicle standards would be approximately $463 in MY 2027, and the average cost for a light heavy-duty emergency vehicle would be approximately $497 in MY 2027. To derive these estimates, the agencies have combined the $7 cost of LRR tires that is presented in Table V–20 with the engine and air conditioning costs presented in Table V–22. The agencies are not aware of any emergency vehicle manufacturer that produces engines, thus most of these costs would be borne by engine manufacturers. While some of the added engine costs may be passed on to emergency vehicle manufacturers and vehicle owners/operators, the overall costs of these technologies are on the order of the Phase 1 vocational vehicle program costs, which are highly cost-effective.

To ensure that only emergency vehicle chassis would be able to certify to these less stringent standards, the agencies propose that manufacturers identify vehicles using the definition at 40 CFR 86.1803–01, which for Phase 2 purposes would be an ambulance or a fire truck. Manufacturers have informed us that it is feasible to identify such vehicles using sales codes or the presence of specialty attributes. The agencies request comment on the merits and drawbacks of aligning the definition of emergency vehicle for purposes of the Phase 2 program with the definition of emergency vehicle for purposes of the light-duty GHG provisions under 40 CFR 86.1818, which includes additional vehicles such as those used by law enforcement.

According to the International Council on Clean Transportation (ICCT), less than one percent of all new heavy-duty truck registrations from 2003 to 2007 were emergency vehicles.[268] On average, the ICCT's data suggest that approximately 5,700 new emergency vehicles are sold in the U.S. each year; about 0.8 percent of the 3.4 million new heavy-duty trucks registered between 2003 and 2007. According to the Fire Apparatus Manufacturers Association, the annual VMT of the newest emergency vehicles ranges from approximately 2,000 to 8,000 miles, as documented in their 2004 Fire Apparatus Duty Cycle White Paper.[269] Because there are relatively few of these vehicles and they travel a relatively small number of miles, the agencies believe that setting less stringent GHG and fuel consumptions standards for these vehicles would not detract from the greater benefits of this rulemaking, and such separate standards are warranted in any case.

(b) Possible Standards for Other Custom Chassis Manufacturers

The agencies request comment on extending the above simplified compliance procedure and less stringent Phase 2 standards to other custom chassis manufacturers—those who offer such a narrow range of products that averaging is not of practical value as a compliance flexibility, and for whom there are not large sales volumes over which to distribute technology development costs. Custom chassis manufacturers that are not small businesses must comply with the Phase 1 standards and are generally doing so, by installing tires with the required coefficient of rolling resistance. We are aware of a handful of U.S. chassis manufacturers serving the recreational vehicle and bus markets who we believe would have a disproportionate compliance burden, should we require compliance with the primary proposed Phase 2 standards.

According to the MOVES model forecast, there will be approximately 1,000 commercial intercity coach buses, 5,000 transit buses, 40,000 school buses, and 90,000 recreational vehicles manufactured new for MY 2018.[270] In each of these markets, specialty chassis manufacturers compete with large vertically integrated manufacturers. We request comment on the merits of offering less stringent standards to small volume chassis manufacturers, and seek comment as well as to other factors the agencies should consider to ensure this

[268] ICCT, May 2009, ''Heavy-Duty Vehicle Market Analysis: Vehicle Characteristics & Fuel Use, Manufacturer Market Shares.''

[269] Fire Apparatus Manufacturer's Association, Fire Apparatus Duty Cycle White Paper, August 2004, available at *http://www.deepriverct.us/firehousestudy/reports/Apparatus-Duty-Cycle.pdf.*

[270] Vehicle populations are estimated using MOVES2014. More information on projecting populations in MOVES is available in the following report: USEPA (2015). ''Population and Activity of On-road Vehicles in MOVES2014—Draft Report'' Docket No. EPA–HQ–OAR–2014–0827.

approach would not have unintended consequences for businesses competing in the vocational vehicle market.

If the agencies were to adopt less stringent standards for custom non-emergency chassis manufacturers, we would expect to limit this by setting a maximum number of eligible vocational chassis annually for each such manufacturer. The agencies request comment on an appropriate sales volume to qualify for these possible standards, and also request comment as to whether the sales volume thresholds should be different for different markets. We further request comment on whether it would adversely affect business competitiveness if custom chassis manufacturers were held to a different standard than commercial chassis manufacturers, and whether the agencies should consider allowing commercial chassis manufacturers competing in these markets to sell a limited number of chassis certified to a less stringent standard.

As an alternative approach, the agencies request comment on providing custom chassis manufacturers with additional lead time to comply. For example, we could allow such manufacturers an additional one or two years to meet each level of the primary proposed vocational vehicle standards.

If the agencies pursued the approach of less stringent standards, we would likely adopt a simplified compliance procedure similar to the one proposed for emergency vehicles. Custom chassis manufacturers would not follow the otherwise applicable Phase 2 proposed approach of entering an engine map in GEM. Instead, a Phase 1 style GEM interface would be made available, where an EPA default engine specified by rule would be simulated in GEM. The vehicle-level standard would be predicated on a simpler set of technologies than the primary proposed Phase 2 standard, most likely lower rolling resistance tires and idle reduction. Because these would not be emergency vehicles, we believe the performance of these vehicles would not be compromised by requiring improvement in tire CRR beyond that of the Phase 1 level. The agencies request comment on whether we should develop separate standards for different vehicle types such as recreational vehicles and buses.

The Small Business Advocacy Review Panel recommended that EPA seek comment on how to design a small business vocational vehicle exemption by means of a custom chassis volume exemption and what sales volume would be an appropriate threshold. The agencies seek comments on all aspects of an approach for custom vocational vehicle chassis manufacturers that would enable us to adopt a final Phase 2 program that would be consistent with the recommendations of the panel.

(c) Off-Road and Low-Speed Vocational Vehicle Exemptions

The agencies are proposing to continue the exemptions in Phase 1 for off-road and low-speed vocational vehicles, with revision. See generally 76 FR 57175. These provisions currently apply for vehicles that are defined as ''motor vehicles'' per 40 CFR 85.1703, but may conduct most of their operations off-road, such as drill rigs, mobile cranes and yard hostlers. Vehicles qualifying under these provisions must be built with engines certified to meet the applicable engine standard, but need not comply with a vehicle-level GHG or fuel consumption standard. In Phase 1, this typically means not needing to install tires with a lower coefficient of rolling resistance. Because manufacturers choosing to exempt vehicles (but not engines) based on the criteria for heavy-duty off road vehicles at 40 CFR 1037.631 and 49 CFR 523.2 will for the first time provide a description to the agencies of how they meet the qualifications for this exemption in their end-of-the year reports in the spring of 2015, we do not have information beyond what we knew at the time of the Phase 1 rules regarding how broadly this provision is being used. Nonetheless, we are proposing to discontinue the criterion for exemption based solely on use of tires with maximum speed rating at or below 55 mph. The agencies are concerned that tires are so easily replaced that this would be an unreliable way to identify vehicles that truly need special consideration. We are proposing to retain the qualifying criteria related to design and use of the vehicle. We invite comments on the proposed revisions to the qualifying criteria in the regulations, including whether the rated speed of the tires should be retained, and whether vehicles intended to be covered by this provision have characteristics that are captured by the proposed criteria.

C. Feasibility of the Proposed Vocational Vehicle Standards

This section describes the agencies' technological feasibility and cost analysis in greater detail. Further detail on all of these technologies can be found in the draft RIA Chapter 2.4 and Chapter 2.9. The variation in the design and use of vocational vehicles has led the agencies to project different technology solutions for each regulatory subcategory. Manufacturers may also find additional means to reduce emissions and lower fuel consumption than the technologies identified by the agencies, and of course may adopt any compliance path they deem most advantageous. The focus of this section is on the feasibility of the proposed standards for non-emergency vocational vehicles. Further, the agencies project that these technology packages would also be feasible for vocational tractors. With typical driving patterns having limited operation at highway speeds, vocational tractors would appropriately be classified as vocational vehicles, with proposed standards that would not be predicated on the performance of aerodynamic devices. The agencies propose to allow vocational tractors to follow the same subcategory assignment process as other vocational vehicles. For example, a beverage tractor intended for local delivery routes may have a driving pattern that is reasonably represented by the proposed Urban test cycle. The agencies request comment on whether vocational tractors would be deficit-generating vehicles if certified as vocational vehicles, where performance would be measured against the proposed vocational vehicle baseline configurations. For example, if a tractor were designed with a higher power engine to carry a heavier payload than presumed in the GEM baseline for that subcategory, would GEM return a value that poorly represents the real world performance of that vehicle, and if so, would that merit a different certification approach for vocational tractors?

NHTSA and EPA collected information on the cost and effectiveness of fuel consumption and CO_2 emission reducing technologies from several sources. The primary sources of information were the Southwest Research Institute evaluation of heavy-duty vehicle fuel efficiency and costs for NHTSA,[271] the 2010 National Academy of Sciences report of Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,[272] TIAX's assessment of technologies to support the NAS panel report,[273] the technology cost analysis conducted by

[271] Reinhart, T, 2015. *Commercial Medium- and Heavy-Duty (MD/HD) Truck Fuel Efficiency Technology Study*—Reports #1 and #2. Washington, DC: National Highway Traffic Safety Administration; and Schubert, R., Chan, M., Law, K. 2015, *Commercial Medium- and Heavy-Duty (MD/HD) Truck Fuel Efficiency Cost Study.* Washington, DC: National Highway Traffic Safety Administration.

[272] See NAS Report, Note 136, above.

[273] See TIAX 2009, Note 137, above.

ICF for EPA,[274] and the 2009 report from Argonne National Laboratory on Evaluation of Fuel Consumption Potential of Medium and Heavy Duty Vehicles through Modeling and Simulation.[275]

(1) What technologies are the agencies considering to reduce the CO_2 emissions and fuel consumption of vocational vehicles?

In assessing the feasibility of the proposed Phase 2 vocational vehicle standards, the agencies evaluated a suite of technologies, including workday idle reduction, improved tire rolling resistance, improved transmissions, improved axles, and weight reduction, as well as their impact on reducing fuel consumption and GHG emissions. The agencies also evaluated aerodynamic technologies and full electric vehicles.

As discussed above, vocational vehicles may be powered by either SI or CI engines. The technologies and feasibility of the proposed engine standards are discussed in Section II. At the vehicle level, the agencies have considered the same suite of technologies and have applied the same reasoning for including or rejecting these vehicle-level technologies as part of the basis for the proposed standards, regardless of whether the vehicle is powered by a CI or SI engine. With the exception of the MY 2027 proposed standards, the analysis below does not distinguish between vehicles with different types of engines. The resulting proposed vehicle standards do reflect the differences arising from the performance of different types of engines over the GEM cycles.

(a) Vehicle Technologies Considered in Standard-Setting

The agencies note that the effectiveness values estimated for the technologies may represent average values, and do not reflect the potentially-limitless combination of possible values that could result from adding the technology to different vehicles. For example, while the agencies have estimated an effectiveness of 0.5 percent for low friction axle lubricants, each vehicle could have a unique effectiveness estimate depending on the baseline axle's oil viscosity rating. For purposes of this proposed rulemaking, NHTSA and EPA believe that employing average values for technology effectiveness estimates is an appropriate way of recognizing the potential variation in the specific benefits that individual manufacturers (and individual vehicles) might obtain from adding a given technology. There may be real world effectiveness that exceeds or falls short of the average, but on-balance the agencies believe this is the most practicable approach for determining the wide ranging effectiveness of technologies in the diverse vocational vehicle arena.

(i) Transmissions

Transmission improvements present a significant opportunity for reducing fuel consumption and CO_2 emissions from vocational vehicles. Transmission efficiency is important for many vocational vehicles as their duty cycles involve high percentages of driving under transient operation. The three categories of transmission improvements the agencies considered for Phase 2 are driveline optimization, architectural improvements, and hybrid powertrain systems.

The agencies believe an effective way to derive efficiency improvements from a transmission is by optimizing it with the engine and other driveline components to balance both performance needs and fuel savings. However, many vocational vehicles today are not operating with such optimized systems. Because customers are able to specify their preferred components in a highly customized build process, many vocational vehicles are assembled with components that were designed more for compatibility than for optimization. To some extent, vertically integrated manufacturers are able to optimize their drivelines. However, this is not widespread in the vocational vehicle sector, resulting primarily, from the multi-stage manufacture process. The agencies project transmission and driveline optimization will yield a substantial proportion of vocational vehicle fuel efficiency and GHG emissions reduction improvements for Phase 2. On average, we anticipate that efficiency improvements of about five percent can be achieved from optimization, or deep integration of drivelines. However, we are not assigning a fixed level of improvement; rather we have developed a test procedure, the powertrain test, for manufacturers to use to obtain improvement factors representative of their systems. See Section V.E and the draft RIA Chapter 3 for a discussion of this proposed test procedure. Depending on the test cycle and level of integration, the agencies believe improvement factors greater than ten percent above the baseline vehicle performance could be achieved. To obtain such benefits across more of the vocational vehicle fleet, the agencies believe there is opportunity for manufacturers to form strategic partnerships and to explore commercial pathways to deeper driveline integration. For example, one partnership of an engine manufacturer and a transmission manufacturer has led to development of driveline components that deliver improved fuel efficiency based on optimization that could not be realized without sharing of critical data.[276]

The agencies project other related transmission technologies would be recognized over the powertrain test along with driveline optimization. These include improved mechanical gear efficiency, more sophisticated shift strategies, more aggressive torque converter lockups, transmission friction reduction, and reduced parasitic losses, as described in the 2009 TIAX report at 4.5.2. Each of these attributes would be simulated in GEM using default values, unless the powertrain test were utilized by the certifying manufacturer. The draft RIA Chapter 4 explains each parameter that would be set as a fixed value in GEM. The expected benefits of improved gear efficiency, shift logic, and torque converter lockup are included in the total projected effectiveness of optimized conventional transmissions using the powertrain test.

Transmission efficiency could also be improved in the time frame of the proposed rules by changes in the architecture of conventional transmissions. Most vocational vehicles currently use torque converter automatic transmissions (AT), especially in Classes 2b-6. According to the 2009 TIAX report, approximately 70 percent of Class 3–6 box and bucket trucks use AT, and all refuse trucks, urban buses, and motor coaches use AT.[277] Automatic transmissions offer acceleration benefits over drive cycles with frequent stops, which can enhance productivity. However, with the diversity of vocational vehicles and drive cycles, other kinds of transmission architectures can meet customer needs, including automated manual transmissions (AMT) and even some manual transmissions (MT).[278]

One type of architectural improvement the agencies project will be developed by manufacturers of all transmission architectures is increased number of gears. The benefit of adding

[274] See ICF 2010, Note 139, above.

[275] Argonne National Laboratory, ''Evaluation of Fuel Consumption Potential of Medium and Heavy Duty Vehicles through Modeling and Simulation.'' October 2009

[276] See Cummins-Eaton partnership at *http://smartadvantagepowertrain.com/*

[277] See TIAX 2009, Note 137, above.

[278] See *http://www.truckinginfo.com/channel/equipment/article/story/2014/10/2015-medium-duty-trucks-the-vehicles-and-trends-to-look-for/page/3.aspx* (downloaded November 2014).

more gears varies depending on whether the gears are added in the range where most operation occurs. The TIAX 2009 report projected that 8-speed transmissions could incrementally reduce fuel consumption by 2 to 3 percent over a 6-speed automatic transmission, for Class 3–6 box and bucket trucks, refuse haulers, and transit buses.[279] Although the agencies estimate the improvement could on average be about two percent for the adding of two gears in the range where significant vehicle operation occurs, we are not assigning a fixed improvement based solely on number of transmission gears. Manufacturers would enter the number of gears and gear ratios into GEM and the model would simulate the efficiency benefit over the applicable test cycle. Because a public version of proposed GEM is being released with these proposed rules, stakeholders are free to use this tool to explore the effectiveness of different numbers of gears and gear ratios over the proposed test cycles. The agencies request comment on all aspects of the GEM tool, including how it models transmissions and shifting strategies. More details on GEM are available in the draft RIA Chapter 4.

Other architectural changes that the agencies project will offer efficiency improvements include improved automated manual transmissions (AMT) and introduction of dual clutch transmissions (DCT). Newer versions of AMT are showing significant improvements in reliability, such that the current generation of transmissions with this architecture is more likely to retain resale value and win customer acceptance than early models.[280] The agencies believe AMT generally compare favorably to manual transmissions in fuel efficiency, and while the degree of improvement is highly driver-dependent, it can be two percent or greater, depending on the drive cycle. See Section III for additional discussion of AMT. The agencies are not assigning fixed average performance levels to compare an AMT with a traditional automatic transmission. Although the lack of a torque converter offers AMT an efficiency advantage in one respect, the lag in power during shifts is a disadvantage. For Phase 2, the agencies have developed validated models of both AMT and AT, as described in the draft RIA Chapter 4. Manufacturers installing AMT or AT would enter the relevant inputs to GEM and the simulation would calculate the performance. Dual clutch transmissions (DCT) designed for medium heavy-duty vocational vehicles are already in production, and could reasonably be expected to be adapted for other weight classes of vocational vehicles during the time frame of Phase 2.[281] Based on supplier conversations, manufacturers intend to match varying DCT designs with the diverse needs of the heavy-duty market. The agencies do not yet have a validated DCT model in GEM, and we are not assigning a fixed performance level for DCT, though we expect the per-vehicle fuel efficiency improvement due to switching from automatic to DCT to be in the range of three percent over the GEM vocational vehicle test cycles. Selection of transmission architecture type (Manual, AMT, AT, DCT) would be made by manufacturers at the time of certification, and GEM would either use this input information to simulate that transmission using algorithms as described in the draft RIA Chapter 4, or fixed improvements may be assigned. The agencies are assigning fixed levels of improvement that vary by test cycle in GEM for AMT when replacing a manual, which for vocational vehicles would be in the HHD Regional subcategory. If a manufacturer elected not to conduct powertrain testing to obtain specific improvements for use of a DCT, GEM would simulate a DCT as if it were an AMT, with no fixed assigned benefit. The draft RIA at Chapter 2.9 describes the projected effectiveness of each type of transmission improvement for each vocational vehicle test cycle.

Hybrid powertrain systems are included under transmission technologies because, depending on the design and degree of hybridization, they may either replace a conventional transmission or be deeply integrated with a conventional transmission. Further, these systems are often manufactured by companies that also manufacture conventional transmissions.

The agencies are including hybrid powertrains as a technology on which some of the proposed vocational vehicle standards are predicated. We project a variety of mild and strong hybrid systems, with a wide range of effectiveness. Mild hybrid systems that offer an engine stop-start feature are discussed below under workday idle reduction. For hybrid powertrains, we are estimating a 22 to 25 percent fuel efficiency improvement over the powertrain test, depending on the duty cycle in GEM for the applicable subcategory. The agencies obtained these estimates by projecting a 27 percent effectiveness over the ARB Transient cycle, and zero percent over the constant-speed highway cruise cycles. With the proposed cycle weightings, this calculates to a 25 percent improvement over the Urban cycle, and 22 percent over the Multi-Purpose cycle. According to the NREL Final Evaluation of UPS Diesel Hybrid-Electric Delivery Vans, the improvement of a hybrid over a conventional diesel in gallons per ton-mile on a chassis dynamometer over the NYC Composite test cycle was 28 percent.[282] NREL characterizes the NYC Composite cycle as more aggressive than most of the observed field data points from the study, and may represent an ideal hybrid cycle in terms of low average speed, high stops per mile, and high kinetic intensity. NREL noted that most of the observed field data points were reasonably represented by the HTUF4 cycle, over which the chassis dynamometer results showed a 31 percent improvement in gallons per ton-mile. In units of grams CO_2 per mile, NREL reported these test results as 22 percent improvement over the NYC Composite cycle and 26 percent improvement over the HTUF4 cycle. Based on these results, and the fact that any improvement from strong hybrids in Phase 2 would not be simulated in GEM, but rather would be evaluated using the powertrain test, the agencies deemed it reasonable to estimate a conservative 27 percent effectiveness over the ARB Transient in setting the stringency of the proposed standards.

The Phase 1 standards were not predicated on any adoption of hybrid powertrains in the vocational vehicle sector. Because the first implementation year of Phase 1 came just three years after promulgation, there was insufficient lead time for development and deployment of the technology.[283] In addition, our proposed Phase 2

[279] See TIAX 2009, Note 137, Table 4–48.

[280] See NACFE Confidence Report: Electronically Controlled Transmissions, at *http://www.truckingefficiency.org/powertrain/automated-manual-transmissions* (January 2015). See also *http://www.overdriveonline.com/auto-vs-manual-transmission-autos-finding-solid-ground-by-sharing-data-with-engines/* (accessed November 2014).

[281] See Eaton Announcement September 2014, available at *http://www.ttnews.com/articles/lmtbase.aspx?storyid=2969&t=Eaton-Unveils-Medium-Duty-Procision-Transmission*.

[282] Lammert, M., Walkowivz, K., NREL, Eighteen-Month Final Evaluation of UPS Second Generation Diesel Hybrid-Electric Delivery Vans, September 2012, NREL/TP–5400–55658.

[283] In addition to concerns over adequacy of lead time, the agencies described concerns over ''modest'' emission reductions. See 76 FR 57234. Even so, in Phase 1 the agencies adopted provisions for hybrids to generate advanced technology credits.

vocational vehicle GEM test cycles are expected to better recognize hybrid technology effectiveness than the Phase 1 hybrid test cycle, especially in the Urban subcategory. Further, our Phase 2 cost analysis shows that hybrid systems designed for LHD and MHD vocational vehicles would cost less than the costs we were projecting in Phase 1. The agencies believe the Phase 2 rulemaking timeframes would offer sufficient lead time to develop, demonstrate, and conduct reliability testing for technologies that are still maturing, including these hybrid technologies.

Several types of vocational vehicles are well suited for hybrid powertrains, and are among the early adopters of this technology. Vehicles such as utility or bucket trucks, delivery vehicles, refuse haulers, and buses have operational usage patterns with either a significant amount of stop-and-go activity or spend a large portion of their operating hours idling the main engine to operate a PTO unit.

The industry is currently developing many variations of hybrid powertrain systems. There are a few hybrid systems in the market today and several more under development. In addition, energy storage systems are improving.[284] Heavy-duty customers are getting used to these systems with the number of demonstration products on the road. Even so, some manufacturers may be uncertain how much investment to make in this technology without clear signals about future market demand. A list of hybrid manufacturers and their products intended for the vocational market is provided in the draft RIA Chapter 2.9.

Some low cost products on the simple end of the hybrid spectrum are available that minimize battery demand through the use of ultracapacitors or only provide power assist at low speeds. Our regulations define a hybrid system as one that has the capacity for energy storage.[285] In the light-duty GHG program a mild hybrid is defined as including an integrated starter generator, a high-voltage battery (above 12v), and a capacity to recover at least 15 percent of the braking energy. In such systems some accessories are usually electrified. Strong hybrids are typically referred to as those that have larger energy recovery and storage capacity, defined at 65 percent braking energy recovery in the light-duty GHG program. Although integration of a strong hybrid system may enable installation of a downsized engine in some cases, the agencies have not projected any vocational engine downsizing for any hybrid systems as part of our Phase 2 technology assessment. This is in part to be conservative in our cost estimates, and in part because in some applications a smaller engine may not be acceptable if it would risk that performance could be sacrificed during some portion of a work day. Depending on the drive cycle and units of measurement, strong hybrids developed to date have seen fuel consumption and CO_2 emissions reductions between 20 and 50 percent in the field.[286]

The agencies are working to reduce barriers related to hybrid vehicle certification. In Phase 1, there is a significant test burden associated with demonstrating the GHG and fuel efficiency performance of vehicles with hybrid powertrain systems. Manufacturers must obtain a conventional vehicle that is identical to the hybrid vehicle in every way except the transmission, test both, and compare the results.[287] In Phase 2, the agencies are proposing that manufacturers would conduct powertrain testing on the hybrid system, and the results of that testing would become inputs to GEM for simulation of the non-powertrain features of the hybrid vehicle, removing a significant test burden.

In discussions with manufacturers during the development of Phase 2, the agencies have learned that meeting the on-board diagnostic requirements for criteria pollutant engine certification continues to be a potential impediment to adoption of hybrid systems. See Section XIV.A.1 for a discussion of regulatory changes proposed to reduce the non-GHG certification burden for engines paired with hybrid powertrain systems. The agencies have also received a letter from the California Air Resources Board requesting consideration of supplemental NO_X testing of hybrids. The agencies request comment on the Air Resources Board's letter and recommendations.[288]

(ii) Axles

The agencies are considering two axle technologies for the vocational vehicle sector. The first is advanced low friction axle lubricants. Under contract with NHTSA, SwRI tested improved driveline lubrication and found measurable improvements by switching from current mainstream products to newer formulations focusing on modified viscometric effects.[289] Synthetic lubricant formulations can offer superior thermal and oxidative stability compared to petroleum or mineral based lubricants. The agencies believe that a 0.5 percent improvement in vocational vehicle efficiency (as for tractors) is achievable through the application of low friction axle lubricants, and have included that value as a fixed value in GEM. Beyond the use of different lubricant formulations, some axle manufacturers are offering products that achieve efficiency improvements by varying the lubrication levels with vehicle speed, reducing churning losses. The agencies request comment on whether we could accept these systems as qualifying for a fixed GEM improvement value. If a manufacturer wishes to demonstrate the benefit of a specific axle technology, an off-cycle technology credit would be necessary. To support such an application, manufacturers could conduct a rear axle efficiency test, as described in the draft RIA Chapter 3.8. Proposed regulations for this test procedure can be found at 40 CFR 1037.560. Our estimated axle lubricating costs do not include operational costs such as refreshing lubricants on a periodic basis. Based on supplier information, it is likely that some advanced lubricants may have a longer drain interval than traditional lubricants. We are estimating the axle lubricating costs for HHD to be the same as for tractors since those vehicles likewise typically have three axles. However, for LHD and MHD vocational vehicles, we scaled down the cost of this technology to reflect the presence of a single rear axle.

The second axle technology the agencies are considering is a design that enables one of the rear axles to disconnect or otherwise behave as if it's a non-driven axle, on vehicles with two rear (drive) axles, commonly referred to as a 6x2 configuration. The agencies have considered two types of 6x2 configurations for vocational vehicles:

[284] Green Fleet Magazine, The Latest Developments in EV Battery Technology, November 2013, available at *http://www.greenfleetmagazine.com/article/story/2013/12/the-latest-developments-in-ev-battery-technology-grn/page/1.aspx*.

[285] EPA's and NHTSA's regulations define a hybrid vehicle as one that ''includes energy storage features . . . in addition to an internal combustion engine or other engine using consumable chemical fuel. . . .'' at 40 CFR 1037.801 and 49 CFR 535.4.

[286] Van Amburg, Bill, CALSTART, Status Report: Alternative Fuels and High-Efficiency Vehicles, Presentation to National Association of Fleet Administrators (NAFA) 2014 Institute and Expo, April 8, 2014.

[287] See test procedures at 40 CFR 1037.555.

[288] California Air Resources Board. Letter from Michael Carter to Matthew Spears dated December 29, 2014. CARB Request for Supplemental NO_X Emission Check for Hybrid Vehicles. Docket EPA–HA–OAR–2014–0827.

[289] Reinhart, T.E. (June 2015). *Commercial Medium- and Heavy-Duty Truck Fuel Efficiency Technology Study—Report #1.* (Report No. DOT HS 812 146). Washington, DC: National Highway Traffic Safety Administration (the 2015 NHTSA Technology Study). For axle improvements see T–270 Delivery Truck Vehicle Technology Results.

Those that are engaged full time on a vehicle, and those that may be engaged only during some types of vehicle operation, such as only when operating at highway cruise speeds. Some early versions of 6x2 technology offered by manufacturers were not accepted by vehicle owners. When the second drive axle is no longer powered, traction may be sacrificed in some cases. Vehicles with earlier versions of this technology have seen reduced residual values in the secondary market. Over the model years covered by the Phase 2 rules, the agencies expect the market to offer significantly improved versions of this technology, with traction control maintained at lower speeds and efficiency gains at highway cruise speeds.[290] Further information about this technology is provided in the feasibility of the tractor standards, Section III, as well as in draft RIA Chapter 2.4.

The efficiency benefit of a 6x2 axle configuration can be duty-cycle dependent. In many instances, vocational vehicles need to operate off-highway, such as at a construction site delivering materials or dumping at a refuse collection facility. In these cases, vehicles with two drive axles may need the full tractive benefit of both drive axles. The part-time 6x2 axle technology is not expected to measurably improve a vehicle's efficiency for vehicles whose normal duty cycle involves performing significant off-highway work, but the agencies do expect this technology to be recognized over a highway cruise cycle.

Some vocational vehicles in the HHD Regional subcategory may see a 6x2 axle configuration as a reasonable option for improving fuel efficiency. As in Phase 1, our vehicle simulation model assumes that only HHD vehicles have two rear axles, so only these could be recognized for adopting this technology. Further, the agencies don't believe the Multipurpose and Urban subcategories include a significant enough highway cycle weighting in the composite cycle for vehicles that operate in this manner to experience a benefit from adopting this technology. The agencies project this can achieve 2 percent benefit at highway cruise;[291] thus, we propose to assign a fixed value in GEM for part-time 6x2 technology of 2.5 percent over the highway cruise cycles, where the specific improvement would be calculated according to the composite weighting of the applicable vocational vehicle test cycle. We request comment on the best way to recognize this technology in Phase 2, either through a GEM calculation or a fixed assigned value, for vocational vehicles.

(iii) Lower Rolling Resistance Tires

Tires are the second largest contributor to energy losses of vocational vehicles, as found in the energy audit conducted by Argonne National Lab.[292] There is a wide range of rolling resistance of tires used on vocational vehicles today. This is in part due to the fact that the competitive pressure to improve rolling resistance of vocational vehicle tires has been less than that found in the line haul tire market. In addition, the drive cycles typical for these applications often lead vocational vehicle buyers to value tire traction and durability more heavily than rolling resistance. The agencies acknowledge there can be tradeoffs when designing a tire for reduced rolling resistance. These tradeoffs can include characteristics such as wear resistance, cost and scuff resistance. However, based on input from tire suppliers, the agencies expect that the LRR tires that will be available in the Phase 2 timeframe will not compromise performance parameters such as traction, handling, wear, retreadability, or structural durability.

After the Phase 1 rules were promulgated, NHTSA and EPA conducted supplemental tire testing. Other data that have become available to the agencies since Phase 1 include pre-certification data provided to manufacturers by tire suppliers in preparation for MY 2014 vehicle certification.[293] The agencies categorized the data by tire position and vehicle application, so that we have a representation of the variety of LRR vocational vehicle tires that are available in the market for the drive position, steer and all-position tires, as well as wide base singles in all positions. Based on our data set that includes results from multiple laboratories, drive tires that are intended for vocational vehicles have an average CRR of 7.8, and steer and all-position tires that are intended for vocational vehicles have an average CRR of 6.7. The results also indicate that there are a variety of wide based single tires that are intended for vocational vehicles, with an average CRR of 6.6. Each of these data sets shows several models of commercial tires are available at levels of CRR ranging generally from 20 percent worse than average to 20 percent better than average. Further details are presented in the draft RIA Chapter 2.

According to the 2015 NHTSA Technology Study, vocational vehicles are likely to see the most benefits from reduced tire rolling resistance when they are driving at 55 mph.[294] This report also found an influence of vehicle weight on the benefits of LRR tires. The study found that both vocational vehicles tested had greater benefits of LRR tires at 100 percent payload than when empty. Also, the T270 delivery box truck that was 4,000 lbs heavier when fully loaded saw slightly greater efficiency gains from LRR tires than the F650 flatbed tow truck over the same cycles. At higher speeds, aerodynamic drag grows, which reduces the rolling resistance share of total vehicle power demand. In highly transient cycles, the power required to accelerate the vehicle inertia overshadows the rolling resistance power demand. In simulation, GEM represents vocational vehicles with fixed vehicle weights, payloads and aerodynamic coefficients. Thus, the benefit of LRR tires will be reflected in GEM differently for vehicles of different weight classes. There will also be further differences arising from the different test cycles. Based on preliminary simulations, it appears the vehicles in GEM most likely to see the greatest fuel efficiency gains from use of LRR tires are those in the MHD weight classes tested over the Regional or Multipurpose duty cycles, where one percent efficiency improvement could be achieved by reducing CRR by four to five percent. Those seeing the least benefit from LRR tires would likely be Class 8 vehicles tested over the Urban or Multipurpose cycles, where one percent efficiency improvement could be achieved by reducing CRR by seven to eight percent.

The agencies propose to continue the light truck (LT) tire CRR adjustment factor that was adopted in Phase 1. See generally 76 FR 57172–57174. In Phase 1, the agencies developed this adjustment factor by dividing the overall vocational test average CRR of 7.7 by the LT vocational average CRR of 8.9. This yielded an adjustment factor of 0.87. After promulgation of the Phase 1 rules, the agencies conducted additional tire CRR testing on a variety of LT tires, most of which were designated as all-

[290] NACFE, Confidence Findings on the Potential of 6x2 Axles, available at *http://nacfe.org/wp-content/uploads/2014/01/Trucking-Efficiency-6x2-Confidence-Report-FINAL–011314.pdf*, January 2014 (downloaded November 2014).

[291] See 2015 NHTSA Technology Study, Note 289, T–700 Class 8 Tractor-Trailer Vehicle Technology Results.

[292] See Argonne National Laboratory 2009 report, Note 275, page 91.

[293] See memorandum dated May 2015 on Vocational Vehicle Tire Rolling Resistance Test Data Evaluation.

[294] See 2015 NHTSA Technology Study, Note 289, T–270 Delivery Truck Vehicle Technology Results

position tires. In addition, manufacturers have submitted to the agencies pre-certification data that include CRR values provided by tire suppliers. For the small subset of newer test tires that were designated as steer tires, the average CRR was 7.8 kg/ton. For the subset of newer test tires that were designated as drive tires, the average CRR was 8.6 kg/ton. However all-position tires had an average CRR of 8.9 kg/ton.[295] Therefore, for LT vocational vehicle tires, we propose to continue allowing the measured CRR values to be multiplied by a 0.87 adjustment factor before entering the values in the GEM for compliance, because this additional testing has not revealed compelling information that a change is needed. We request comment on whether the adjustment factor should be retained, as well as data on which to base a possible update of its numerical value.

As described above in V. B. (4) (c), the agencies are proposing to continue the Phase 1 off-road and low speed exemptions in Phase 2, with the proposed revision of discontinuing the option to qualify for this exemption solely if the vehicle is fitted with tires that have a maximum speed rating at or below 55 mph. The agencies welcome comments on this revision.

(iv) Workday Idle Reduction

The Phase 2 idle reduction technologies considered for vocational vehicles are those that reduce workday idling, unlike the overnight idling of combination tractors. There are many potential technologies. The agencies in particular evaluated neutral idle and stop-start technologies, and the proposed standards are predicated on projected amounts of penetrations of these technologies, described in Section V. C. (2) . While neutral idle is necessarily a transmission technology, stop-start could range from an engine technology to one that would be installed by a secondary manufacturer under a delegated assembly agreement.

The agencies are aware that for a vocational vehicle's engine to turn off during workday driving conditions, there must be a reserve source of energy to maintain functions such as power steering, cabin heat, and transmission pressure, among others. Stop-start systems can be viewed as having a place on the low-cost end of the hybridization continuum. As described in Section V. C. (2) and in the draft RIA Chapter 2.9, the agencies are including the cost of energy storage sufficient to maintain critical onboard systems and restart the engine as part of the cost of vocational vehicle stop-start packages. The technologies to capture this energy could include a system of photovoltaic cells on the roof of a box truck, or regenerative braking. The technologies to store the captured energy could include a battery or a hydraulic pressure bladder. More discussion of stop-start technologies is found in the draft RIA Chapter 2.4.

The agencies intend for the technologies that would qualify to be recognized in GEM as stop-start to be broadly defined, including those that may be installed at different stages in the manufacturing process. The agencies request comment on an appropriate definition of stop-start technologies for vocational vehicles.

The agencies are also proposing a certification test cycle that measures the amount of fuel saved and CO_2 reduced by these two primary types of idle reduction technologies: neutral idle and stop-start. Vocational vehicles frequently also idle while cargo is loaded or unloaded, and while operating a PTO such as compacting garbage or operating a bucket. In these rules, the agencies are proposing that the Regional duty cycle have ten percent idle, the Multi-purpose cycle have 15 percent idle, and the Urban cycle have 20 percent idle. These estimates are based on publically available data published by NREL.[296] To bolster this information, EPA entered into an interagency agreement with NREL to characterize workday idle among vocational vehicles. One task of this agreement is to estimate the nationally representative fraction of idle operation for vocational vehicles for each proposed regulatory subcategory including a distinction between idling while driving or stopping in gear, and idling while parked. The preliminary range of total daily idle operation per vehicle indicated by this work is about 18 percent to 33 percent when combining the data from all available vehicles. The agencies request comment regarding the nature of vocational workday idle operation, including how much of it is in traffic and how much is while the vehicle is parked. Depending on comments and additional information received during the comment period, it may be within the agencies' discretion to adopt different final test cycles, or re-weight the current test cycles, to better represent real world driving and better reflect performance of the technology packages. An analysis of possible vocational vehicle standards derived from alternate characterizations of idle operation has been prepared by the agencies, and is available for review in the public docket for this rulemaking.[297]

Based on GEM simulations using the currently proposed vocational vehicle test cycles, the agencies estimate neutral idle for automatic transmissions to provide fuel efficiency improvements ranging from one percent to nearly four percent, depending on the regulatory subcategory. The agencies estimate stop-start to provide fuel efficiency improvements ranging from 0.5 percent to nearly seven percent, depending on the regulatory subcategory. Because of the higher idle weighting factor in the Urban test cycle, vehicles certified in these subcategories would derive the greatest benefit from applying idle reduction technologies.

Although the primary program would not simulate vocational vehicles over a test cycle that includes PTO operation, the agencies are proposing to continue, with revisions, the hybrid-PTO test option that was in Phase 1. See 76 FR 57247 and 40 CFR 1037.525 (proposed to be redesignated as 40 CFR 1037.540). Recall that we are proposing to regulate vocational vehicles at the incomplete stage when a chassis manufacturer may not know at the time of certification whether a PTO will be installed or how the vehicle will be used. Based on stakeholder input, chassis manufacturers are expected to know whether a vehicle's transmission is PTO-enabled. However, that is very different from knowing whether a PTO will actually be installed and how it will be used. Chassis manufacturers may rarely know whether the PTO-enabled vehicle will use this capability to maneuver a lift gate on a delivery vehicle, to operate a utility boom, or merely to keep it as a reserve item to add value in the secondary market. In cases where a manufacturer can certify that a PTO with an idle-reduction technology will be installed either by the chassis manufacturer or by a second stage manufacturer, the hybrid-PTO test cycle may be utilized by the certifying manufacturer to measure an improvement factor over the GEM duty cycle that would otherwise apply to that vehicle. In addition, the delegated assembly provisions would apply. See Section V.E for a description of the delegated assembly provisions. See draft RIA Chapter 3 for a discussion of the proposed revisions to the PTO test cycle.

[295] See tire memorandum, Note 293.

[296] See NREL data at *http://www.nrel.gov/vehiclesandfuels/fleettest/research_fleet_dna.html*.

[297] See memorandum dated May 2015 on Analysis of Possible Vocational Vehicle Standards Based on Alternative Idle Cycle Weightings.

The agencies have reason to believe there may be a NO_X co-benefit to stop-start idle reduction technologies, e-PTO, and possibly also to neutral idle. For this to be true, the benefits of reduced fuel consumption and retained aftertreatment temperature would have to outweigh any extra emissions due to re-starts. In the draft RIA Chapter 2.9, there is a more detailed discussion of the relationship between idle reduction and NO_X co-benefits. The agencies request comments and relevant test data that can help inform this issue.

(v) Weight Reduction

The agencies believe there is opportunity for weight reduction in some vocational vehicles. According to the 2009 TIAX report, there are freight-efficiency benefits to reducing weight on vocational vehicles that carry heavy cargo, and tax savings potentially available to vocational vehicles that remain below excise tax weight thresholds. This report also estimates that the cost effectiveness of weight reduction over urban drive cycles is potentially greater than the cost effectiveness of weight reduction for long haul tractors and trailers. On a city duty cycle, 89 percent of the vehicle's road load is weight dependent, compared to 38 percent on a steady-state 55 mph duty cycle.[298] The 2015 NHTSA Technology Study found that weight reduction provides a greater fuel efficiency benefit for vehicles driving under transient conditions than for those operating under constant speeds. In simulation, the study found that the two Class 6 trucks improved fuel efficiency by over two percent on the ARB transient cycle by removing 1,100 lbs. Further, SwRI observed that the improvements due to weight reduction behaved linearly.[299] The proposed menu of components available for a vocational vehicle weight credit in GEM is presented in Section V.E and in the draft RIA Chapter 2.9. It includes fewer options than for tractors, but the agencies believe there are a number of feasible material substitution choices at the chassis level, which could add up to weight savings on the order of a few hundred lbs. The agencies project that refuse trucks, construction vehicles, and weight-limited regional delivery vehicles could reasonably apply material substitution for weight reduction. We do not expect this to be broadly applicable across many types of vocational vehicles. Based on the assumed payload in GEM, and depending on the vocational vehicle subcategory, the agencies believe a reduction of 200 lbs may offer a fuel efficiency improvement of approximately 1 to 2 percent.

Without more specific data on which to base our assumptions, the agencies are proposing to allocate 50 percent of any mass reduction to increased payload, and 50 percent to reduce the chassis weight. We considered the data on which the tractor weight allocation (1/3:2/3) is based, but determined this would not be valid for vocational vehicles, as the underlying data pertained only to long haul tractor-trailers. The agencies propose that 50 percent of weight removed from vocational vehicle chassis would be added back as additional payload in GEM. This suggests an equal likelihood that a vehicle would be reducing weight for benefits of being lighter, or reducing weight to carry more payload. The agencies welcome data that could better inform the fraction of weight reduced for vocational vehicles that is added back as payload.

The agencies request comment on whether the HD Phase 2 program should recognize that weight reduction of rotating components provides an enhanced fuel efficiency benefit over weight reduction on static components. In theory, as components such as brake rotors, brake drums, wheels, tires, crankshafts, camshafts, and piston assemblies become lighter, the power consumption to rotate the masses would be directly proportional to the mass decrease. Using physical properties of a rotating component such as a wheel, it is relatively straightforward to calculate an equivalent mass. However, we do not have enough information to derive industry average values for equivalent mass, nor have we evaluated the best way for GEM to account for this.

(vi) HFC Refrigerant From Cabin Air Conditioning (A/C) Systems

Manufacturers can reduce direct A/C leakage emissions by utilizing leak-tight components. EPA's proposed HFC direct emission leakage standard would be independent of the CO_2 vehicle standard. Manufacturers could choose components from a menu of leak-reducing technologies sufficient to comply with the standard, as opposed to using a test to measure performance. See 76 FR 57194.

In Phase 1, EPA adopted a HFC leakage standard to assure that high-quality, low-leakage components are used in each air conditioning system installed in HD pickup trucks, vans, and combination tractors (see 40 CFR 1037.115). We did not adopt a HFC leakage standard in Phase 1 for systems installed in vocational vehicles. EPA is proposing in Phase 2 to extend the HFC leakage standard that exists due to Phase 1 requirements to all vocational vehicles. Beginning in the 2021 model year, EPA proposes that vocational vehicle air conditioning systems with a refrigerant capacity of greater than 733 grams meet a leakage rate of 1.50 percent leakage per year and systems with a refrigerant capacity of 733 grams or lower meet a leakage standard of 11.0 grams per year. EPA believes this proposed approach of having a leak rate standard for lower capacity systems and a percent leakage per year standard for higher capacity systems would result in reduced refrigerant emissions from all air conditioning systems, while still allowing manufacturers the ability to produce low-leak, lower capacity systems in vehicles which require them.

EPA believes that reducing A/C system leakage is both highly cost-effective and technologically feasible. The availability of low leakage components is being driven by the air conditioning program in the light-duty GHG rule which began in the 2012 model year and the HD Phase 1 rule that began in the 2014 model year. The cooperative industry and government Improved Mobile Air Conditioning program has demonstrated that new-vehicle leakage emissions can be reduced by 50 percent by reducing the number and improving the quality of the components, fittings, seals, and hoses of the A/C system.[300] All of these technologies are already in commercial use and exist on some of today's systems, and EPA does not anticipate any significant improvements in sealing technologies for model years beyond 2021. However, EPA has recognized some manufacturers utilize an improved manufacturing process for air conditioning systems, where a helium leak test is performed on 100 percent of all o-ring fittings and connections after final assembly. By leak testing each fitting, the manufacturer or supplier is verifying the o-ring is not damaged during assembly (which is the primary source of leakage from o-ring fittings), and when calculating the yearly leak rate for a system, EPA will allow a relative emission value equivalent to a 'seal washer' can be used in place of the value normally used for an o-ring fitting, when 100 percent helium leak testing is performed on those fittings. The agencies request comment on other

[298] Helms 2003 as referenced in TIAX 2009.

[299] See 2015 NHTSA Technology Study, Note 289, T–270 Delivery Truck Vehicle Technology Results and Vehicle Performance in the F–650 Truck.

[300] Team 1-Refrigerant Leakage Reduction: Final Report to Sponsors, SAE, 2007.

possible improvements in the design of air conditioning systems that EPA could recognize for the purposes of compliance with this proposed standard. For example, should the agency recognize electrified compressors as having a zero leak rate, and should we allow vehicles fitted with electrified compressors to use a simplified version of the compliance reporting form? Please see Section I.F.1 (b) of this preamble for a description of proposed program-wide revisions to EPA's HFC leakage standards that would address air conditioning systems designed for alternative refrigerants.

The HFC control costs presented in the draft RIA Chapter 2.9 and 2.12 are applied to all heavy-duty vocational vehicles. EPA views these costs as minimal and the reductions of potent GHGs to be easily feasible and reasonable in the lead times provided by the proposed rules.

(b) Engine Technologies Considered in Vehicle Standard-Setting

Section II explains the technical basis for the agencies' proposed separate engine standards. The agencies are not proposing to predicate the vocational vehicle standards on different diesel engine technology packages than those presumed for compliance with the separate diesel engine standards. However, for the proposed MY 2027 vocational vehicle standards, the agencies are predicating the SI-powered vocational vehicle standards on a gasoline engine technology package that includes additional friction reduction beyond that presumed for compliance with the MY 2016 gasoline engine standard. Chapter 2 of the draft RIA provides more details on each of the technologies that can be applied to both gasoline and diesel engines.

The vehicle-level standards would vary depending on whether the engines powering those vehicles are compression-ignition or spark-ignition.[301] In Phase 1, this was not the case because GEM used a default engine that was the same for every vehicle configuration, regardless of the actual engine being installed. As described above in Section II, the Phase 2 vehicle certification tool, GEM, would require manufacturers to enter specific engine performance data, where emissions and fuel consumption profiles would differ significantly depending on the engine's architecture.[302]

As explained in Section II.A.2, engines would continue to be certified over the FTP test cycle. The FTP test cycle that is applicable for bare vocational engines is very different than the proposed test cycles for vocational vehicles in GEM. The FTP is a very demanding transient cycle that exercises the engine over its full range of capabilities. In contrast, the cycles evaluated by GEM measure emissions over more frequently used engine operating ranges. The ARB Transient vehicle cycle represents city driving, and the highway cruise cycles measure engine operation that is closer to steady state. Each of these cycles is described in the draft RIA Chapter 3. A consequence of recognizing engine performance at the vehicle level would be that further engine improvements (*i.e.* improvements measureable by duty cycles that more precisely represent driving patterns for specific subcategories of vocational vehicles) could be evaluated as possible components of a technical basis for a vocational vehicle standard.[303] For this reason, the agencies considered whether any different engine technologies should be included in the feasibility analysis for the vehicle standards (and potentially, in the proposed standard stringency).

One CI engine technology that might be recognized over a vehicle highway cruise cycle would be waste heat recovery (WHR). However, the agencies do not consider this to be a feasible technology for vocational engines. As described in Section II of this preamble and Chapter 2.3 of the draft RIA, there currently are no commercially available WHR systems for diesel engines, although most engine manufacturers are exploring this technology. While it would be possible to capture excess heat from a vocational engine operating at highway speeds, many vocational vehicles spend insufficient time at highway speeds to generate enough excess heat to make this technology worthwhile. As explained in Section II.D, the agencies are projecting a very small adoption rate of WHR even in the tractor engine market. Because the research is currently being conducted to apply this technology for tractors, it is logical that future research may reveal ways to adapt this technology for those vocational engines that are intended for on-highway applications. The agencies do not believe this technology will be developed to the point of commercial readiness for vocational vehicles in the time frame of these proposed rules.

The agencies assessed three SI engine technologies for possible inclusion in the vocational vehicle technology packages: cylinder deactivation, variable valve timing, and advanced friction reduction. These might be recognized over the proposed vocational vehicle test cycles in GEM through use of the proposed engine mapping procedures. To the extent either cylinder deactivation or variable valve timing would be adopted for complete heavy-duty pickups and vans, they would be recognized over the complete chassis test specified for that segment and possibly over the GEM highway cruise cycles, however the aggressive bare engine FTP test is unlikely to put the engine into operating modes that activate either of those technologies. Based on stakeholder input, the agencies project that the SI engines certified over the FTP and fitted into vocational vehicles would most likely be designed as overhead valve engines, for which the only kind of VVT available is dual cam phasing.[304] Dual cam phasing is already included at 100 percent adoption rate in the feasibility and stringency of the MY 2016 bare engine standard. If manufacturers choose to fit vocational vehicles with coaxial camshaft SI engines, additional VVT options would be feasible and could be recognized over the vocational vehicle test cycles. Based on stakeholder input, the agencies project that some SI engines certified over the FTP and fitted into vocational vehicles may be designed with cylinder deactivation by MY 2021. However, the agencies do not have enough information at this time to quantify the potential fuel efficiency improvements over the vocational vehicle test cycles for engines with cylinder deactivation or various designs implementing VVT. Therefore we are not proposing to predicate the SI-powered vocational vehicle standards on use of these technologies.

In Section II.D, the agencies explain why we are not proposing a more stringent separate SI vocational engine standard in Phase 2 based on additional engine technologies beyond those assumed for the Phase 1 MY 2016 standard. The agencies are instead proposing to include adoption and performance of advanced engine friction reduction technology as a basis for the

[301] Specifically, EPA is proposing CO_2, N_2O, and CH_4 emission standards for new heavy-duty engines over an EPA specified useful life period (*See* Section II).

[302] See Section II.D.5 for an explanation of which engine architecture would need to meet which standard.

[303] As noted in II.B.2 above, manufacturers also have greater flexibility to meet a vehicle standard if engine improvements can be evaluated as part of compliance testing.

[304] See preamble Section VI.C.5.(a) under Coupled Cam Phasing.

proposed SI-powered vocational vehicle standards. Based on Volpe model results presented in preamble Section VI, the agencies project that manufacturers of some SI engines for complete HD pickups would apply advanced friction reduction. Level 2 engine friction reduction is listed in Table VI–3, and costs are presented in the draft RIA Chapter 2.12. We expect some engines with this technology would be engine-certified and sold for use in vocational vehicles. We are projecting an overall effectiveness of 0.6 percent improvement over the GEM cycles for this technology, calculated using a per-vehicle effectiveness of 1.1 percent and a vocational vehicle adoption rate of 56 percent. We request comment on the merits of setting a SI-based vocational vehicle standard predicated on adoption of SI engine technologies.

(c) Technologies the Agencies Assessed but Did Not Use in Standard-Setting

(i) Aerodynamics

The Argonne National lab work shows that aerodynamics has less of an impact on vocational vehicle energy losses than do engines or tires.[305] Further, when a vehicle spends significant time at slower speeds, the disbenefit of the added weight of the aero devices diminishes the benefit obtained when driving at high speeds. In addition, the aerodynamic performance of a complete vehicle is significantly influenced by the body of the vehicle. As noted above, the agencies are not proposing to regulate body builders for the reasons discussed in Phase 1.

The NAS 2010 report estimated a one percent fuel efficiency improvement could be achieved from a full aerodynamic package on a box truck with an average speed of 30 mph.[306] Both from the NAS 2010 report and from experiences of EPA's SmartWay team, the agencies expect the potential benefits of aerodynamics at an average speed of 60 mph would be diminished by 50 percent or more when average speeds are closer to 40 mph. The proposed Regional composite duty cycle in GEM for vocational vehicles (the test cycle with the most highway weighting) has a weighted average speed of 39 mph.

The 2015 NHTDA Technology Study simulated a Class 6 box truck with a coefficient of aerodynamic drag that had been improved by 15 percent. Over transient test cycles, this produced a one percent fuel efficiency benefit, though this produced results of approximately seven percent improvement over the 55 mph and eight percent over the 65 mph cycle. SwRI conducted coastdown testing to determine the baseline C_DA of the truck, of 5.0.[307] However, it is unknown what aerodynamic technologies could be applied to yield a 15 percent improvement in C_DA. Using these simulation results and the proposed Regional cycle weightings of 22 percent at 65 mph and 28 percent at 55 mph, the agencies estimate the fuel efficiency benefit of improving the CdA of a Class 6 box truck by 15 percent could be approximately four percent. This assumes no penalty for carrying the weight of the aerodynamic devices while operating under transient driving conditions.

Because we do not have information on specific technologies that could be applied to vocational vehicles to yield a 15 percent improvement in CdA, or their costs, we are not basing any of the proposed standards for vocational vehicles on aerodynamic improvements. Nonetheless, we are working with CARB to incorporate into GEM some data from testing that is being conducted by CARB through NREL. A test plan is underway to assess the fuel efficiency benefit of three different devices to improve the aerodynamic performance of a Class 6 box truck and one device on a Class 4 box truck. The agencies request comment on allowing a manufacturer to obtain an improved GEM result by certifying that a final vehicle configuration will closely match one of the configurations on which this testing was conducted, where the improvement would be based on installation of specific aerodynamic devices for which we have pre-defined effectiveness through this testing program. The amount of improvement would be set by EPA and NHTSA based on NREL's test results. This credit provision would apply only to vocational vehicles certified over the Regional duty cycle. Manufacturers wishing to receive credit for other aerodynamic technologies or on other vehicle configurations would be able to seek credit for it as an off-cycle technology. See Section V.E, for a description of regulatory flexibilities such as off-cycle technology credits.

A description of vehicles and aerodynamic technologies that could be eligible for this option, as well as a description of the testing conducted to obtain the assigned GEM improvements due to these technologies, can be found in a memorandum to the docket.[308] The agencies seek comment on this potential approach to providing credits for aerodynamic aids to vocational box trucks.

(ii) Full Electric Trucks

Some heavy-duty vehicles can be powered exclusively by electric motors. Electric motors are efficient and able to produce high torque, giving e-trucks strong driving characteristics, particularly in stop-and-go or urban driving situations, and are well-suited for moving heavy loads. Electric motors also offer the ability to operate with very low noise, an advantage in certain applications. Currently, e-trucks have some disadvantages over conventional vehicles, primarily in cost, weight and range. Components are relatively expensive, and storing electricity using currently available technology is expensive, bulky, and heavy.

The West Coast Collaborative, a public-private partnership, has estimated the incremental costs for electric Class 3–6 trucks in the Los Angeles, CA, area.[309] Compared to a conventional diesel, the WCC estimates a BEV system would cost between $70,000 and $90,000 more than a conventional diesel system. The CalHEAT Technology Roadmap includes an estimate that the incremental cost for a fully-electric medium- or heavy- duty vehicle would be between $50,000 and $100,000. This roadmap report also presents several actions that must be taken by manufacturers and others, before heavy-duty e-trucks can reach what they call Stage 3 Deployment.[310]

Early adopters of electric drivetrain technology are medium-heavy-duty vocational vehicles that are not weight-limited and have drive cycles where they don't need to go far from a central garage. Examples include Frito-Lay. CalHEAT has published results of a comprehensive performance evaluation of three battery electric truck models using information and data from in-use data collection, on road testing and chassis dynamometer testing.[311]

[305] See Argonne National Laboratory 2009 report, Note 275, above.

[306] See Table 5–10 of the NAS 2010 report, Note 136.

[307] See 2015 NHTSA Technology Study, Note 289, Appendix C.

[308] See May 2015 memorandum to the docket titled Vocational Vehicle Aerodynamic Testing Program.

[309] See *http://westcoastcollaborative.org/files/sector-fleets/WCC-LA-BEVBusinessCase2011-08-15.pdf*.

[310] Silver, Fred, and Brotherton, Tom. (CalHEAT) Research and Market Transformation Roadmap to 2020 for Medium- and Heavy-Duty Trucks. California Energy Commission, June 2013.

[311] Gallo, Jean-Baptiste, and Jasna Tomic (CalHEAT). 2013. Battery Electric Parcel Delivery Truck Testing and Demonstration. California Energy Commission.

Given the high costs and the developing nature of this technology, the agencies do not project fully electric vocational vehicles to be widely commercially available in the time frame of the proposed rules. For this reason, the agencies have not based the proposed Phase 2 standards on adoption of full-electric vocational vehicles. To the extent this technology is able to be brought to market in the time frame of the Phase 2 program, there is currently a certification path for these chassis from Phase 1, as described in Section V.E and in EPA's regulations at 40 CFR 1037.150 and NHTSA's regulations at 49 CFR 535.8.

(iii) Electrified Accessories

Accessories that are traditionally gear- or belt-driven by a vehicle's engine can be optimized and/or converted to electric power. Examples include the engine water pump, oil pump, fuel injection pump, air compressor, power-steering pump, cooling fans, and the vehicle's air-conditioning system. Optimization and improved pressure regulation may significantly reduce the parasitic load of the water, air and fuel pumps. Electrification may result in a reduction in power demand, because electrically-powered accessories (such as the air compressor or power steering) operate only when needed if they are electrically powered, but they impose a parasitic demand all the time if they are engine-driven. In other cases, such as cooling fans or an engine's water pump, electric power allows the accessory to run at speeds independent of engine speed, which can reduce power consumption. Electrification of accessories can individually improve fuel consumption, regardless of whether the drivetrain is a strong hybrid. The TIAX study used 2 to 4 percent fuel consumption improvement for accessory electrification, with the understanding that electrification of accessories will have more effect in short haul/urban applications and less benefit in line-haul applications.[312]

Electric power steering (EPS) or Electrohydraulic power steering (EHPS) provides a potential reduction in CO_2 emissions and fuel consumption over hydraulic power steering because of reduced overall accessory loads. This eliminates the parasitic losses associated with belt-driven power steering pumps which consistently draw load from the engine to pump hydraulic fluid through the steering actuation systems even when the wheels are not being turned. EPS is an enabler for all vehicle hybridization technologies since it provides power steering when the engine is off. EPS is feasible for most vehicles with a standard 12V system. Some heavier vehicles may require a higher voltage system which may add cost and complexity.

The agencies are projecting that some electrified accessories will be necessary as part of the development of stop-start idle reduction systems for vocational vehicles. However, the agencies have not developed a pre-defined credit-generating option for manufacturers to directly receive credit in GEM for electrified accessories on vocational vehicles. Manufacturers wishing to conduct independent testing may apply for off-cycle credits derived from electrified accessories.

(iv) E–PTO

There are products available today that can provide auxiliary power, usually electric, to a vehicle that needs to work in PTO mode for an extended time, to avoid idling the main engine. There are different designs of electrified PTO systems on the market today. Some designs have auxiliary power sources, typically batteries, with sufficient energy storage to power an onboard tool or device for a short period of time, and are intended to be recharged during the workday by operating the main engine, either while driving between work sites, or by idling the engine until a sufficient state of charge is reached that the engine may shut off. Other designs have sufficient energy storage to power an onboard tool or device for many hours, and are intended to be recharged as a plug-in hybrid at a home garage. The agencies are proposing to continue the hybrid-PTO test option that was available in Phase 1, with a few revisions. See the proposed regulations at 40 CFR 1037.540. The current test procedure is a charge-sustaining procedure, meaning the test is not complete until the energy storage system is depleted and brought back to its original state of charge. The agencies request comment and data relating to the population and energy storage capacity of plug-in e-PTO systems, for which a charge-depleting test cycle may be more appropriate. For the reasons described above in Section V.C.1.a.iv, the agencies are not basing the proposed vocational vehicle standards on use of electrified PTO or hybrid PTO technology. Manufacturers wishing to conduct testing as specified may apply for off-cycle credits derived from e-PTO or hybrid PTO technologies.

(2) Projected Vehicle Technology Package Effectiveness and Cost

(a) Baseline Vocational Engine and Vehicle Performance

The proposed baseline vocational vehicle configurations for each of the nine proposed regulatory subcategories are described in draft RIA Chapter 2.9 and Chapter 4.4. The agencies propose to set the baseline rolling resistance coefficient for the 2017 vocational vehicle fleet at 7.7 kg/metric ton, which assumes 100 percent of tires meet the Phase 1 standard.

In the agencies' proposed baseline configurations, we include torque converter automatics with five forward gears in eight of the nine subcategories. In the Regional HHD subcategory, the baseline includes a manual transmission with ten forward gears. No additional vehicle-level efficiency-improving technology is included in the baseline vehicles, nor in the agencies' analyses for the no-action reference case. Specifically, we have assumed zero adoption rates for other types of transmissions, increased numbers of gears, idle reduction, and technologies other than Phase 1 compliant LRR tires in both the nominally flat baseline and the dynamic baseline reference cases. Technology adoption rates for Alternative 1a (nominally flat baseline) can be found in the draft RIA Chapter 2.12. Chapter 2.12.8 presents the adoption rates for tires on vocational vehicles with different levels of rolling resistance, including the 100 percent adoption rate of tires with Level 1 CRR in the reference case and in model years preceding Phase 2. In this manner, we have defined a reference vocational vehicle fleet that meets the Phase 1 standards and includes reasonable representations of vocational vehicle technology and configurations. Details of the vehicle configurations, including reasons why they are reasonably included as baseline technologies, are discussed in the draft RIA Chapter 2.9.

The agencies note that the baseline performance derived for the proposed rules varies between regulatory subcategories—as noted above, this is the reason the agencies are proposing the further subcategories. The range of performance at baseline is due to the range of attributes and modeling parameters, such as transmission characteristics, final drive ratio, and vehicle weight, which were selected to represent a range of performance across this diverse segment. The agencies request comment on whether the proposed configurations adequately represent a reasonable range of vocational chassis configurations likely

[312] TIAX 2009, Note 137, pp. 3–5.

to be manufactured in the implementation years of the Phase 2 program. We especially are interested in comments regarding the following driveline parameters: Transmission gear ratios, axle ratios, and tire radii.

The baseline engine fuel consumption represents improvements beyond currently available engines to achieve the efficiency of what the agencies believe would be a 2017 model year diesel engine, as described in the draft RIA Chapter 2. Using the values for compression-ignition engines, the baseline performance of vocational vehicles is shown in Table V–11.

Different types of diesel engines are used in vocational vehicles, depending on the application. They fall into the categories of Light, Medium, and Heavy Heavy-duty Diesel engines. The Light Heavy-duty Diesel engines typically range between 4.7 and 6.7 liters displacement. The Medium Heavy-duty Diesel engines typically have some overlap in displacement with the Light Heavy-duty Diesel engines and range between 6.7 and 9.3 liters. The Heavy Heavy-duty Diesel engines typically are represented by engines between 10.8 and 16 liters. Because of these differences, the GEM simulation of baseline vocational CI engines includes four engines—one for LHD, one for MHD, and two for HHD. Detailed descriptions can be seen in Chapter 4 of the draft RIA. These four engine models have been employed in setting the vocational vehicle baselines, as described in the draft RIA Chapter 2.9.

TABLE V–11—BASELINE VOCATIONAL VEHICLE PERFORMANCE WITH CI ENGINES

Duty cycle	Light heavy-duty class 2b–5	Medium heavy-duty class 6–7	Heavy heavy-duty class 8
Baseline Emissions Performance in CO_2 gram/ton-mile			
Urban	316	201	212
Multi-Purpose	325	203	214
Regional	339	199	203
Baseline Fuel Efficiency Performance in gallon per 1,000 ton-mile			
Urban	31.0413	19.7446	20.8251
Multi-Purpose	31.9253	19.9411	21.0216
Regional	33.3006	19.5481	19.9411

The agencies intend to develop a model in GEM of a MY 2016-compliant gasoline engine, but we have been unable to obtain sufficient information to complete this process. The agencies request comments on the process for mapping gasoline engines for simulation purposes, as well as information about the power rating and displacement that should be considered as a baseline SI engine for vocational vehicle standard-setting purposes. In lieu of a SI engine map, the agencies have applied a correction factor to the GEM CI vocational simulation results, to approximate the baseline performance of a SI-powered vocational vehicle. The SI-powered vocational vehicle baseline performance shown in Table V–12 was calculated from applying an adjustment factor to the respective CI-powered vocational vehicle baseline values. This CI to SI baseline adjustment factor is derived from the Phase 1 HD pickup and van stringency curves, as described in the draft RIA Chapter 2.9.1. The correction factor approach is not the agencies' preferred approach, as it has many drawbacks. One key drawback with this approach is that it does not account for the fact that SI engines operate very differently than CI engines at idle. Our current model includes information on CI engine idle performance, and assumes transmissions and torque converters appropriate for CI engines. We expect these driveline parameters would be very different for SI powered vehicles, which would affect performance over all the GEM duty cycles.

The baseline performance levels for HHD vocational vehicles powered by SI engines were derived using the same procedures described above for the MHD and LHD vehicles, adjusting the performance of the HHD CI powered vocational vehicles by the same degree as for the other vehicles. However, we expect that any gasoline Class 8 vocational vehicle would be powered by a MHD SI engine, as there are no HHD gasoline engines on the market. Further, we expect that if we were to develop an engine map for use in simulating heavier SI vocational vehicles in GEM, we could establish a more representative baseline performance level by calculating the work done by the MHD engine to move the heavier vehicle over the test cycles. The agencies request comments on the merits of developing separate baseline levels and numerical standards for HHD vocational vehicles powered by SI engines, including any benefits that could be obtained by addressing this unlikely occurrence and other ways in which the agencies could avoid the instance of an orphaned SI vocational vehicle. Commenters who favor separate numerical standards are encouraged to submit information related to appropriate default vehicle characteristics such as weight and payload. Depending on comments, the agencies could choose to require all Class 8 vocational vehicles to certify to the standards for CI powered HHD vocational vehicles, or we could require SI powered Class 8 vocational vehicles to certify to the MHD standards for SI vocational vehicles.

TABLE V–12—BASELINE VOCATIONAL VEHICLE PERFORMANCE WITH SI ENGINES

Duty cycle	Light heavy-duty Class 2b–5	Medium heavy-duty Class 6–7	Heavy heavy-duty Class 8
Baseline Emissions Performance in CO_2 gram/ton-mile			
Urban	334	213	224

TABLE V–12—BASELINE VOCATIONAL VEHICLE PERFORMANCE WITH SI ENGINES—Continued

Duty cycle	Light heavy-duty Class 2b–5	Medium heavy-duty Class 6–7	Heavy heavy-duty Class 8
Multi-Purpose	344	215	226
Regional	358	211	214
Baseline Fuel Efficiency Performance in gallon per 1,000 ton-mile			
Urban	37.5830	23.9676	25.2054
Multi-Purpose	38.7082	24.1926	25.4304
Regional	40.2836	23.7425	24.0801

(b) Technology Packages for Derivation of Proposed Standards

Prior to developing the numerical values for the proposed standards, the agencies projected the mix of new technologies and technology improvements that would be feasible within the proposed lead time. We note that for some technologies, the adoption rates and effectiveness may be very similar across subcategories. However, for other technologies, either the adoption rate, effectiveness, or both differ across subcategories. The standards being proposed reflect the technology projected for each service class. Where a technology performs differently over different test cycles, these differences are reflected to some extent in the derivation of the stringency of the proposed standard. However, the proposed standard stringency does reflect, to some extent, the ability of manufacturers to utilize credits. For example, we project that hybrid vehicles would generally be certified in the Urban subcategory and would generate emission credits that would most likely be used in the other subcategories within the weight class group.[313]

As part of the derivation of the numerical standards, we performed a benchmarking analysis to inform our development of standards that would have roughly equivalent stringency among the duty-cycle-based subcategories within each weight class group. To do this, the agencies assessed the performance of broadly applicable technologies, such as low rolling resistance tires, on each of the selected baseline vehicles over each of the duty cycles. We then evaluated how much improvement could be achieved over the various duty cycles for a vehicle that incorporated all the broadly applicable technologies, but which did not include a hybrid powertrain. We simulated neutral idle for benchmarked vehicles for MY 2021 and MY 2024, and simulated stop-start idle reduction on the benchmarked MY 2027 vehicles. From this, we learned that a vehicle with neutral idle and a deeply integrated conventional powertrain, with moderately low rolling resistance tires and some weight reduction could easily meet the proposed standards in the early implementation years of the program, in any weight class or duty cycle. We also learned how the effectiveness of tire rolling resistance and weight reduction vary in GEM (*i.e.* and therefore likely in actual operation) across the different subcategories. We also found that a vehicle with a deeply integrated conventional powertrain, tires with even lower CRR, some weight reduction, and stop-start idle reduction could achieve the MY 2027 proposed standards. However, our technology feasibility does not presume that 100 percent of vocational vehicles can reasonably apply deep powertrain integration, nor do we project 100 percent adoption of LRR tires or weight reduction.

The technologies assumed for the benchmarked vehicles are summarized in Table V–13, Table V–14, and Table V–15. Note that the agencies are not projecting that these are the vehicles that would actually be produced. Rather, these theoretical vehicles are being evaluated to compare the relative stringency of the standards for each subcategory.

TABLE V–13—GEM INPUTS FOR BENCHMARKED MY 2021 VOCATIONAL VEHICLES

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Transmission								
100% Deep Transmission Integration for 7% Urban, 6% Multipurpose, 5% Regional								
5s AT	5s AT	5s AT	5s AT	5s AT	5s AT	5s AT	5s AT	10s AMT

[313] See averaging sets at 40 CFR 1037.740.

TABLE V–13—GEM INPUTS FOR BENCHMARKED MY 2021 VOCATIONAL VEHICLES—Continued

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
CI Engine [a]								
2021 MY 7L, 200 hp Engine			2021 MY 7L, 270 hp Engine			2021 MY 11L, 345 hp Engine		2021 MY 15L 455hp Engine
100% Idle Reduction = Neutral Idle								
100% improved axle lubrication: 0.5%								
100% Steer Tires with CRR 6.9 kg/metric ton								
100% Drive Tires with CRR 7.3 kg/metric ton								
Weight Reduction 200 lb								

Note:
[a] SI engines were not simulated in GEM.

TABLE V–14—GEM INPUTS FOR BENCHMARKED MY 2024 VOCATIONAL VEHICLES

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Transmission								
100% Deep Transmission Integration for 7% Urban, 6% Multipurpose, 5% Regional								
5s AT	5s AT	5s AT	5s AT	5s AT	5s AT	5s AT	5s AT	10s AMT
CI Engine [a]								
2024 MY 7L, 200 hp Engine			2024 MY 7L, 270 hp Engine			2024 MY 11L, 345 hp Engine		2024 MY 15L 455hp Engine
100% Idle Reduction = Neutral Idle								
100% improved axle lubrication: 0.5%								
100% Steer Tires with CRR 6.7 kg/metric ton								
100% Drive Tires with CRR 7.1 kg/metric ton								
Weight Reduction 200 lb								

Note:
[a] SI engines were not simulated in GEM.

TABLE V–15—GEM INPUTS FOR BENCHMARKED MY 2027 VOCATIONAL VEHICLES

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Transmission								
100% Deep Transmission Integration for 7% Urban, 6% Multipurpose, 5% Regional								
5s AT	5s AT	5s AT	5s AT	5s AT	5s AT	5s AT	5s AT	10s AMT

TABLE V–15—GEM INPUTS FOR BENCHMARKED MY 2027 VOCATIONAL VEHICLES—Continued

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
CI Engine[a]								
2027 MY 7L, 200 hp Engine			2027 MY 7L, 270 hp Engine			2027 MY 11L, 345 hp Engine		2027 MY 15L 455hp Engine
100% Idle Reduction = Stop-Start								
100% Steer Tires with CRR 6.4 kg/metric ton								
100% Drive Tires with CRR 7.0 kg/metric ton								
Weight Reduction 200 lb								

Note:
[a] SI engines were not simulated in GEM.

Next we identified the best performing baseline vehicle in each weight class group (one for HHD, one for MHD and one for LHD) and normalized the baseline GEM results to the performance of that vehicle. A complete description of this normalization process is found in the draft RIA Chapter 2. We then applied our actual projected technology adoption rates, including hybrid powertrains and stop-start idle reduction, to normalized-benchmarked vehicles in each of the nine subcategories. The proposed standards then were calculated by multiplying the normalized baseline vehicle GEM result by an average percent improvement for each weight class group. For example, the GEM results from applying the projected technology mix for MY 2021 MHD CI vocational vehicles were a 5 percent improvement in the Regional MHD subcategory, 7 percent improvement in the MHD Multipurpose subcategory, and 8 percent improvement in the MHD Urban subcategory. To achieve standards with equivalent stringency, we multiplied each normalized baseline vehicle's GEM performance by the numerical average of those simulated improvements, 6.6 percent. Without comparable stringency across the subcategories, manufacturers could have an incentive to select a subcategory strategically to have a less stringent standard, rather than to certify vehicles in the subcategory that best matches the vehicles' expected use patterns. By setting the standards at the same percent reduction from each weight class group of normalized-benchmarked vehicles, we would expect to minimize any incentive for a manufacturer to certify a vocational vehicle in an inappropriate subcategory.

We request comment on using this approach to normalize the standards. Commenters are encouraged to address both the approach in general and the specific technology assumed for the benchmark vehicles.

We are aware that in this approach, some of the projected technology packages would not provide a direct path to compliance for manufacturers, such as in the example above of the MHD Regional vehicle. Using the technologies adopted at projected rates, it would fall short of the standard by 1.5 percent. The agencies believe that the Phase 2 program has enough regulatory flexibility (averaging, banking, and trading provisions in particular) to enable such a vehicle to be certified.

In the package descriptions that follow, individual technology costs are not presented, rather these can be found in the draft RIA Chapter 2.9 and 2.12. Section V. C. (2) (d) includes the costs estimated for packages of technologies the agencies project would enable vocational vehicles to meet the proposed Phase 2 standards.

(i) Transmission Packages

The agencies project that 30 percent of vocational vehicles would have one or more of the transmission technologies identified above in this section applied by MY 2021, increasing to nearly 60 percent by MY 2024 and over 80 percent by MY 2027. Most of this increase is due to a projected increase in adoption of technologies that represent deep driveline integration. The agencies project an adoption rate of 15 percent in MY 2021 and 30 percent in MY 2024 for manufacturers using the powertrain test to be recognized for non-hardware upgrades such as gear efficiencies, shift strategies, and torque converter lockups, as well as other technologies that enable driveline optimization. Due to the relatively high efficiency gains available from driveline optimization for relatively low costs, the agencies are projecting a 70 percent application rate of driveline optimization by MY 2027 across all subcategories. We do not have information about the extent to which integration may be deterred by barriers to information-sharing between component suppliers. Therefore we are projecting that major manufacturers would work to overcome these barriers, integrate and optimize their drivelines, and use the powertrain test on all eligible configurations, while smaller manufacturers may not adopt these technologies at all, or not to a degree that they would find value in this optional test procedure.

For the technology of adding two gears, we are predicating the proposed MY 2021 standard on a five percent adoption rate, except zero in the HHD Regional subcategory, which is modeled with a 10-speed transmission. This adoption rate is projected to essentially remain at this level throughout the program, with an increase to ten percent only for two subcategories (Regional LHD and MHD) in MY 2027. This is because the manufacturers most likely to develop 8-speed transmissions are those that are also developing transmissions for HD pickups and vans, and the GEM-certified vocational market share among those manufacturers is relatively small.

The HHD Regional subcategory is the only one where we assume a manual transmission in the baseline configuration. For these vehicles, the agencies project upgrades to electronic transmissions such as either AMT, DCT, or automatic, at collective adoption rates of 51 percent in MY 2021, 68 percent in MY 2024, and five percent in MY 2027. The decrease in MY 2027 reflects a projection that a greater number of deeply integrated HHD powertrains would be used by MY 2027 (one consequence being that fewer HHD powertrains would be directly simulated in GEM in that year). The larger numbers in the phase-in years reflect powertrains that have been automated or electrified but not deeply integrated. The agencies have been careful to account for the cost of both electrifying and deeply integrating the MY 2027 powertrains. In draft RIA Chapter 11, the technology adoption rates for the HHD Regional subcategory presented in Table 11–42, Table 11–45, and Table 11–48 account for the assumption that a manual transmission cannot be deeply integrated, so there must also be an automation upgrade. These tables are inputs to the agencies' cost analysis, thus the costs of both upgrading and integrating HHD powertrains are included. The adoption rates of the upgraded but not integrated transmission architectures represent a projection of three percent of all vocational vehicles in MY 2021 and four percent in MY 2024. This is based on an estimate that seven percent of the vocational vehicles would be in the HHD Regional subcategory. For more information about the assumptions that were made about the populations of vehicles in different subcategories, see the agencies' inventory estimates in draft RIA Chapter 5.

In the eight subcategories in which automatic transmissions are the base technology, the agencies project that five percent would upgrade to a dual clutch transmission in MY 2021. This projection increases to 15 percent in MY 2024 and decreases in MY 2027 to ten percent for two subcategories (Regional LHD and MHD) and five percent for the remaining 6 subcategories. The low projected adoption rates of DCT reflect the fact that this is a relatively new technology for the heavy-duty sector, and it is likely that broader market acceptance would be achieved once fleets have gained experience with the technology. Similar to the pattern described for the HHD Regional subcategory, the decrease in MY 2027 reflects a projection of greater use of deeply integrated powertrains.

In setting the proposed standard stringency, we have projected that hybrids on vehicles certified in the Multipurpose subcategories would achieve on average 22 percent improvement, and those in the Urban subcategories would see a 25 percent improvement. We have also projected zero hybrid adoption rate by vehicles in the Regional subcategories, expecting that the benefit of hybrids for those vehicles would be too low to merit use of that type of technology. However, there is no fixed hybrid value assigned in GEM and the actual improvement over the applicable test cycle would be determined by powertrain testing. By the full implementation year of MY 2027, the agencies are projecting an overall vocational vehicle adoption rate of ten percent hybrids, which we estimate would be 18 percent of vehicles certified in the Multi-Purpose and Urban subcategories. We are projecting a low adoption rate in the early years of the Phase 2 program, just four percent in these subcategories in MY 2021, and seven percent in MY 2024 for vehicles certified in the Multi-Purpose and Urban subcategories. Based on our assumptions about the populations of vehicles in different subcategories, these hybrid adoption rates are about two percent overall in MY 2021 and four percent overall in MY 2024.

Considering the combination of the above technologies and adoption rates, we project the CO_2 and fuel efficiency improvements for all transmission upgrades to be approximately seven percent on a fleet basis by MY 2027. One subcategory in which we are projecting a very large advanced transmission adoption rate is the HHD Regional subcategory, in which we are projecting 75 percent of the transmissions would be either automated or automatic (upgraded from a manual) with 70 percent of those also being deeply integrated by MY 2027. By comparison, the agencies are projecting that HHD day cab tractors would have 90 percent adoption of automated or automatic transmissions by MY 2027. Although we are not prepared to predict what fraction of these would be upgraded in the absence of Phase 2, the draft RIA Chapter 2.9 explains why the agencies are confident that durable transmissions will be widely available in the Phase 2 time frame to support manufacture of HHD vocational vehicles.

If the above technologies do not reach the expected level of market adoption, the vocational vehicle Phase 2 program has several other technology options that manufacturers could choose to meet the proposed standards.

(ii) Axle Packages

The agencies project that 75 percent of vocational vehicles in all subcategories would adopt advanced axle lubricant formulations in all implementation years of the Phase 2 program. Fuel efficient lubricant formulations are widespread across the heavy-duty market, though advanced synthetic formulations are currently less popular.[314] Axle lubricants with improved viscosity and efficiency-enhancing performance are projected to be widely adopted by manufacturers in the time frame of Phase 2. Such formulations are commercially available and the agencies see no reason why they could not be feasible for most vehicles. Nonetheless, we have refrained from projecting full adoption of this technology. The agencies do not have specific information regarding reasons why axle manufacturers may specify a specific type of lubricant over another, and whether advanced lubricant formulations may not be recommended in all cases. The agencies request comment on information regarding any vocational vehicle applications for which use of advanced lubricants would not be feasible.

The agencies estimate that 45 percent of HHD Regional vocational vehicles would adopt either full time or part time 6x2 axle technology in MY 2021. This technology is most likely to be applied to Class 8 vocational vehicles (with 2 rear axles) that are designed for frequent highway trips. The agencies project a slightly higher adoption rate of 60 percent combined for both full and part time 6x2 axle technologies in MY 2024 and MY 2027. Based on our estimates of vehicle populations, this is about four percent of all vocational vehicles.

(iii) Tire Packages

The agencies estimate that the per-vehicle average level of rolling resistance from vocational vehicle tires could be reduced by 11 percent by full implementation of the Phase 2 program in MY 2027, based on the tire development achievements expected over the next decade. This is estimated by weighting the projected improvements of steer tires and drive tires using an assumed axle load distribution of 30 percent on the steer tires and 70 percent on the drive tires, as explained in the draft RIA Chapter 2.9. The projected adoption rates and expected improvements in CRR are presented in Table V–16. By applying the assumed axle load distribution, the average vehicle CRR improvements projected for the proposed MY 2021 standards would be four percent, which we project would achieve up to one percent reduction in fuel use and CO_2 emissions, depending on the vehicle subcategory. Using that same method, the agencies estimate the average vehicle CRR in MY 2024 would be seven percent, yielding reductions in fuel use and CO_2 emissions of between one and two percent, depending on the vehicle subcategory.

The agencies understand that the vocational vehicle segment has access to

[314] Based on conversations with axle suppliers.

a large variety of tires, including some that are designed for tractors, some that are designed for HD pickups and vans, and some with multiple use designations. In spite of the likely availability of LRR tires during the Phase 2 program, the projected adoption rates are intended to be conservative. The agencies believe that these tire packages recognize the variety of tire purposes and performance levels in the vocational vehicle market, and maintain choices for manufacturers to use the most efficient tires (*i.e.* those with least rolling resistance) only where it makes sense given these vehicles' differing purposes and applications.

TABLE V–16—PROJECTED LRR TIRE ADOPTION RATES

Tire position	Level of rolling resistance	MY 2021 adoption rate	MY 2024 adoption rate	MY 2027 adoption rate
Drive	Baseline CRR (7.7)	50	20	10
Steer	Baseline CRR (7.7)	20	10	0
Drive	5% Lower CRR (7.3)	50	50	25
Steer	10% Lower CRR (6.9)	80	30	20
Drive	10% Lower CRR (6.9)	0	30	50
Steer	15% Lower CRR (6.5)	0	60	30
Drive	15% Lower CRR (6.5)	0	0	15
Steer	20% Lower CRR (6.2)	0	0	50
Drive	Average Improvement in CRR	3%	6%	9%
Steer	Average Improvement in CRR	8%	12%	17%

For comparison purposes, the reader may note that these levels of tire CRR generally correspond with levels of tire CRR projected for tractors built for the Phase 1 standards. For example, the baseline level CRR for vocational tires is very similar to the baseline tractor steer tire CRR. Vocational vehicle tires with 10 percent better CRR have a similar CRR level as tractor tires of Drive Level 1. Vocational vehicle tires with 15 percent better CRR have a similar CRR level as tractor tires of Steer Level 1. Vocational vehicle tires with 20 percent better CRR have a similar CRR level as tractor tires of Drive Level 2, as described in Section III.D.2.

(iv) Idle Reduction Packages

In this proposal, we are projecting a progression of idle reduction technology development that begins with 70 percent adoption rate of neutral idle for the MY 2021 standards, which by MY 2027 is replaced by a 70 percent adoption rate of stop-start idle reduction technology. Although it is possible that a vehicle could have both neutral idle and stop-start, we are only considering emissions reductions for vehicles with one or the other of these technologies. Also, as the program phases in, we do not see a reduction in the projected adoption rate of neutral idle to be a concern in terms of stranded investment, because it is a very low cost technology that could be an enabler for stop-start systems in some cases.

We are not projecting any adoption of neutral idle for the HHD Regional subcategory, because any vehicle with a manual transmission must shift to neutral when stopped to avoid stalling the engine, so that vehicles in the HHD Regional subcategory would already essentially be idling in neutral and no additional technology would be needed to achieve this. A similar case can be made for any vocational vehicle with an automated manual transmission, since these share inherently similar architectures with manuals. The agencies are not projecting an adoption rate of 85 percent neutral idle until MY 2024, because it may take some additional development time to apply this technology to high-torque automatic transmissions designed for the largest vocational vehicles. Based on stakeholder input, the designs needed to avoid an uncomfortable re-engagement bump when returning to drive from neutral may require some engineering development time as well as some work to enable two-way communication between engines and transmissions.

We are projecting a five percent adoption rate of stop-start in the six MHD and LHD subcategories for MY 2021 and zero for the HHD vehicles, because this technology is still developing for vocational vehicles and is most likely to be feasible in the early years of Phase 2 for vehicles with lower power demands and lower engine inertia. Stopping a heavy-duty engine is not challenging. The real challenge is designing a robust system that can deliver multiple smooth restarts daily without loss of function while the engine is off. Many current light-duty products offer this feature, and some heavy-duty manufacturers are exploring this.[315] The agencies are projecting an adoption rate of 15 percent stop-start across all subcategories in the intermediate year of MY 2024. The agencies are projecting this technology to have a relatively high adoption rate (70 percent as stated above) by MY 2027 because we see it being technically feasible on the majority of vocational vehicles, and especially effective on those with the most time at idle in their workday operation. Although we are not prepared to predict what fraction of vehicles would adopt stop-start in the absence of Phase 2, the draft RIA Chapter 2.9 explains why the agencies are confident that this technology, which is on the entry-level side of the hybrid and electrification spectrum, will be widely available in the Phase 2 time frame.

Based on these projected adoption rates and the effectiveness values described above in this section, we expect overall GHG and fuel consumption reductions from workday idle on vocational vehicles to be approximately three percent in MY 2027.

(v) Weight Reduction Packages

As described in the draft RIA Chapter 2.12, weight reduction is a relatively costly technology, at approximately $3 to $4 per pound for a 200-lb package. Even so, for vehicles in service classes where dense, heavy loads are frequently carried, weight reduction can translate directly to additional payload. The agencies project weight reduction would most likely be used for vocational vehicles in the refuse and construction service classes, as well as some regional delivery vehicles. The agencies are

[315] See Ford announcement December 2013, *https://media.ford.com/content/fordmedia/fna/us/en/news/2013/12/12/70-percent-of-ford-lineup-to-have-auto-start-stop-by-2017—fuel-.html.* See also Allison-Cummins announcement July 2014, *http://www.oemoffhighway.com/press_release/12000208/allison-stop-start?utm_source=OOH+Industry+News+eNL&utm_medium=email&utm_campaign=RCL140723006.*

predicating the proposed standards on an adoption rate of five to eight percent, depending on the subcategory, in MY 2027, with slightly lower adoption rates in MY 2021 and MY 2024.

For this technology package, NHTSA and EPA project manufacturers would use material substitution in the amount of 200 lbs. An example of how this weight could be reduced would be a complete set of aluminum wheels for a Class 8 vocational vehicle, or an aluminum transmission case plus high strength steel wheels, frame rails, and suspension brackets on a MHD or LHD vocational vehicle. The agencies have limited information about how popular the use of aluminum components is in the vocational vehicle sector. We request comments with information on whether any lightweight vocational vehicle components are in such widespread use that we should exclude them from the list of components for which a GEM improvement value would be available.

(c) GEM Inputs for Derivation of Proposed Vocational Vehicle Standards

To derive the stringency of the proposed vocational vehicle standards, the agencies developed a suite of fuel consumption maps for use with the GEM: One set of maps that represent engines meeting the proposed MY 2021 vocational diesel engine standards, a second set of maps representing engines meeting the proposed MY 2024 vocational diesel engine standards, and a third set of maps representing engines meeting the proposed MY 2027 vocational diesel engine standards.[316] By incorporating the engine technology packages projected to be adopted to meet the proposed Phase 2 vocational CI engine standards, the agencies employed GEM engine models in deriving the stringency of the proposed Phase 2 CI-powered vocational vehicle standards. As noted above, because the agencies did not have enough information to develop a robust GEM-based gasoline engine fuel map, the stringency of the proposed SI-powered vocational vehicle standards is derived as an adjustment from the CI-powered vocational vehicle standards. See the draft RIA Chapter 2.9 for more details about this adjustment process.

Depending on the particular technology, either the effectiveness was assigned by the agencies using an accepted average value, or the GEM tool was used to assess the proposed technology effectiveness, as discussed above. The agencies derived a scenario vehicle for each subcategory using the adoption rate and assigned or modeled improvement values of transmission, axle, and idle reduction technologies. For example, the MY 2021 CRR values for each subcategory scenario case were derived as follows: For steer tires—20 percent times 7.7 plus 80 percent times 6.9 yields an average CRR of 7.1 kg/metric ton; and for drive tires—50 percent times 7.7 plus 50 percent times 7.3 yields an average CRR of 7.5 kg/metric ton. Similar calculations were done for weight reduction, transmission improvements, and axle improvements. The set of tire CRR, idle reduction, weight reduction, engine and transmission input parameters that was modeled in GEM in support of the proposed MY 2021 vocational vehicle standards is shown in Table V–17. The agencies derived the level of the proposed MY 2024 standards by using the tire, weight reduction, engine and transmission GEM inputs shown in Table V–18, below. The agencies derived the level of the proposed MY 2027 standards by using the tire, weight reduction, engine and transmission GEM inputs shown in Table V–19, below. As post-processing, the respective adoption rates and assigned improvement values of transmission, axle, and idle reduction technologies were calculated for each subcategory.

The agencies have not directly transferred the GEM results from these inputs as the proposed standards. Rather, the proposed standards are the result of the normalizing and benchmarking analysis described above. The proposed standards are presented in Table V–4 through Table V–9. Additional detail is provided in the RIA Chapter 2.9.

TABLE V–17—GEM INPUTS USED TO DERIVE PROPOSED MY 2021 VOCATIONAL VEHICLE STANDARDS

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
CI Engine [a]								
2021 MY 7L, 200 hp Engine 200 hp Engine			2021 MY 7L, 270 hp Engine			2021 MY 11L, 345 hp Engine		2021 MY 15L 455hp Engine
Transmission (improvement factor)								
0.023	0.021	0.008	0.023	0.021	0.009	0.023	0.022	0.022
Axle (improvement factor)								
0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.012
Stop-Start (adoption rate)								
5%	5%	5%	5%	5%	5%	0%	0%	0%
Neutral Idle (adoption rate)								
70%	70%	70%	70%	70%	70%	70%	70%	0%
Steer Tires (CRR kg/metric ton)								
7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1

[316] *See* Section II.D.2 of this preamble for the derivation of the engine standards.

TABLE V–17—GEM INPUTS USED TO DERIVE PROPOSED MY 2021 VOCATIONAL VEHICLE STANDARDS—Continued

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Drive Tires (CRR kg/metric ton)								
7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Weight Reduction (lb)								
8	8	14	8	8	12	8	8	10

Note:
[a] SI engines were not simulated in GEM, rather a gas/diesel adjustment factor was applied to the results.

TABLE V–18—GEM INPUTS USED TO DERIVE PROPOSED MY 2024 VOCATIONAL VEHICLE STANDARDS

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
CI Engine[a]								
2024 MY 7L, 270 hp Engine			2024 MY 11L, 345 hp Engine			2024 MY 15L, 455hp Engine		2024 MY 15L 455hp Engine
Transmission (improvement factor)								
0.045	0.04	0.017	0.045	0.041	0.018	0.045	0.042	0.035
Axle (improvement factor)								
0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.014
Stop-Start (adoption rate)								
15%	15%	15%	15%	15%	15%	15%	15%	15%
Neutral Idle (adoption rate)								
85%	85%	85%	85%	85%	85%	85%	85%	0%
Steer Tires (CRR kg/metric ton)								
6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Drive Tires (CRR kg/metric ton)								
7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Weight Reduction (lb)								
8	8	14	8	8	12	8	8	10

Note:
[a] SI engines were not simulated in GEM, rather a gas/diesel adjustment factor was applied to the results.

TABLE V–19—GEM INPUTS USED TO DERIVE PROPOSED MY 2027 VOCATIONAL VEHICLE STANDARDS

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
CI Engine [a]								
2027 MY 7L, 200 hp Engine			2027 MY 7L, 270 hp Engine			2027 MY 11L, 345 hp Engine		2027 MY 15L 455hp Engine
Transmission (improvement factor)								
0.096	0.085	0.034	0.096	0.088	0.037	0.097	0.089	0.036
Axle (improvement factor)								
0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.014

TABLE V–19—GEM INPUTS USED TO DERIVE PROPOSED MY 2027 VOCATIONAL VEHICLE STANDARDS—Continued

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Stop-Start (adoption rate)								
75%	70%	70%	75%	70%	70%	70%	70%	70%
Neutral Idle (adoption rate)								
25%	30%	30%	25%	30%	30%	30%	30%	0%
Steer Tires (CRR kg/metric ton)								
6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Drive Tires (CRR kg/metric ton)								
7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Weight Reduction (lb)								
10	10	16	10	10	14	10	10	12

Note:
[a] SI engines were not simulated in GEM, rather a gas/diesel adjustment factor was applied to the results.

(d) Technology Package Costs

The agencies have estimated the costs of the technologies that could be used to comply with the proposed standards. The estimated costs are shown in Table V–20 for MY2021, in Table V–21 for MY2024, and Table V–22 for MY 2027. Fleet average costs are shown for light, medium and heavy HD vocational vehicles in each duty-cycle-based subcategory—Urban, Multi-Purpose, and Regional. As shown in Table V–20, in MY 2021 these range from approximately $600 for MHD and LHD Regional vehicles, up to $3,400 for HHD Regional vehicles. Those two lower-cost packages reflect zero hybrids, and the higher-cost package reflects significant adoption of automated transmissions. In the draft RIA Chapter 2.13.2, the agencies present vocational vehicle technology package costs differentiated by MOVES vehicle type. For example, intercity buses are estimated to have an average package cost of $2,900 and gasoline motor homes are estimated to have an average package cost of $450 in MY 2021. These costs do not indicate the per-vehicle cost that may be incurred for any individual technology. For more specific information about the agencies' estimates of per-vehicle costs, please see the draft RIA Chapter 2.12. For example, Chapter 2.12.7 describes why a complex technology such as hybridization is estimated to range between $15,000 and $40,000 per vehicle for vocational vehicles in MY 2021. The engine costs listed represent the cost of an average package of diesel engine technologies as set out in Section II. Individual technology adoption rates for engine packages are described in Section II.D. The details behind all these costs are presented in draft RIA Chapter 2.12, including the markups and learning effects applied and how the costs shown here are weighted to generate an overall cost for the vocational segment. We welcome comments on our technology cost assessments.

TABLE V–20—VOCATIONAL VEHICLE TECHNOLOGY INCREMENTAL COSTS FOR THE PROPOSAL IN THE 2021 MODEL YEAR[A B]

[2012$]

	Light HD			Medium HD			Heavy HD		
	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Engine[c]	$293	$293	$293	$270	$270	$270	$270	$270	$270
Tires	7	7	7	7	7	7	7	7	7
Transmission	81	81	81	81	81	81	81	81	2,852
Axle related	99	99	99	99	99	99	148	148	219
Weight Reduction	27	27	48	27	27	41	27	27	34
Idle reduction	49	49	49	51	51	51	6	6	0
Electrification & hybridization	547	547	0	861	861	0	1,437	1,437	0
Air Conditioning[d]	22	22	22	22	22	22	22	22	22
Total	1,125	1,125	598	1,418	1,418	571	1,998	1,998	3,404

Notes:

[a] Costs shown are for the 2021 model year and are incremental to the costs of a vehicle meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated vehicle classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see RIA 2.9 in particular).

[c] Engine costs are for a light HD, medium HD or heavy HD diesel engine. We are projecting no additional costs beyond Phase 1 for gasoline vocational engines.

[d] EPA's air conditioning standards are presented in Section V.C above.

The estimated fleet average vocational vehicle package costs are shown in Table V–21 for MY 2024. As shown, these range from approximately $800 for MHD and LHD Regional vehicles, up to $4,800 for HHD Regional vehicles. The increased costs above the MY 2021 values reflect increased adoption rates of individual technologies, while the individual technology costs are generally expected to remain the same or decrease, as explained in the draft RIA Chapter 2.12. For example, Chapter 2.12.7 presents MY 2024 hybridization costs that range from $13,000 to $33,000 per vehicle for vocational vehicles. The engine costs listed represent the average costs associated with the proposed MY 2024 vocational diesel engine standard described in Section II.D.

TABLE V–21—VOCATIONAL VEHICLE TECHNOLOGY INCREMENTAL COSTS FOR THE PROPOSAL IN THE 2024 MODEL YEAR[a b]

[2012$]

	Light HD			Medium HD			Heavy HD		
	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Engine[c]	$437	$437	$437	$405	$405	$405	$405	$405	$405
Tires	17	17	17	17	17	17	23	23	23
Transmission	123	123	123	123	123	123	123	123	3,915
Axle related	90	90	90	90	90	90	136	136	224
Weight Reduction	24	24	43	24	24	37	24	24	30
Idle reduction	119	119	119	125	125	125	224	224	217
Electrification & hybridization	906	906	0	1,423	1,423	0	2,377	2,377	0
Air Conditioning[d]	20	20	20	20	20	20	20	20	20
Total	1,737	1,737	849	2,228	2,228	817	3,332	3,332	4,834

Notes:

[a] Costs shown are for the 2024 model year and are incremental to the costs of a vehicle meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated vehicle classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see RIA 2.9 in particular).

[c] Engine costs are for a light HD, medium HD or heavy HD diesel engine. We are projecting no additional costs beyond Phase 1 for gasoline vocational engines.

[d] EPA's air conditioning standards are presented in Section V.C above.

The estimated fleet average vocational vehicle package costs are shown in Table V–22 for MY 2027. As shown, these range from approximately $1,400 for MHD and LHD Regional vehicles, up to $7,400 for HHD Urban and Multipurpose vehicles. These two subcategories are projected to have the higher-cost packages in MY 2027 due to an estimated 18 percent adoption of HHD hybrids, which are estimated to cost $31,000 per vehicle in MY 2027, as shown in Chapter 2.12.7 of the draft RIA. These per-vehicle technology package costs were averaged using our projections of vehicle populations in the nine regulatory subcategories and do not correspond to the MOVES vehicle types. The engine costs shown represent the average costs associated with the proposed MY 2027 vocational diesel engine standard described in Section II.D. For gasoline vocational vehicles, the agencies are projecting adoption of Level 2 engine friction reduction with an estimated $68 added to the average SI vocational vehicle package cost in MY 2027, which represents about 56 percent of those vehicles upgrading beyond Level 1 engine friction reduction. Further details on how these SI vocational vehicle costs were estimated are provided in the draft RIA Chapter 2.9.

Purchase prices of vocational vehicles can range from $60,000 for a stake-bed landscape truck to over $400,000 for some transit buses. The costs of the vocational vehicle standards can be put into perspective by considering package costs estimated using MOVES vehicle types along with typical prices for those vehicles. For example, a package cost of $4,000 on a $60,000 short haul straight truck would represent an incremental increase of about six percent of the vehicle purchase price. Similarly, a package cost of $7,000 on a $200,000 refuse truck would represent an incremental increase of less than four percent of the vehicle purchase price. The vocational vehicle industry characterization report in the docket includes additional examples of vehicle prices for a variety of vocational applications.[317]

[317] See industry characterization, Note 260, above.

TABLE V–22—VOCATIONAL VEHICLE TECHNOLOGY INCREMENTAL COSTS FOR THE PROPOSAL IN THE 2027 MODEL YEAR[a] [b]

[2012$]

	Light HD			Medium HD			Heavy HD		
	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Engine[c]	$471	$471	$471	$437	$437	$437	$437	$437	$437
Tires	20	20	20	20	20	20	29	29	29
Transmission	244	244	267	244	244	267	244	244	2,986
Axle related	86	86	86	86	86	86	129	129	215
Weight Reduction	29	29	46	29	29	40	29	29	35
Idle reduction	498	499	499	526	526	526	964	964	962
Electrification & hybridization	2,122	2,122	0	3,336	3,336	0	5,571	5,571	0
Air Conditioning[d]	19	19	19	19	19	19	19	19	19
Total	3,489	3,490	1,407	4,696	4,696	1,395	7,422	7,422	4,682

Notes:

[a] Costs shown are for the 2024 model year and are incremental to the costs of a vehicle meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated vehicle classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see RIA 2.9 in particular).

[c] Engine costs are for a light HD, medium HD or heavy HD diesel engine. We are projecting no additional costs beyond Phase 1 for gasoline vocational engines.

[d] EPA's air conditioning standards are presented in Section V.C above.

(3) Consistency of the Proposed Vocational Vehicle Standards With the Agencies' Legal Authority

NHTSA and EPA project the proposed standards to be achievable within known design cycles, and we believe these standards, although technology-forcing, would allow many different paths to compliance in addition to the example outlined in this section. The proposed standards are predicated on manufacturers implementing technologies that we expect will be available in the time frame of these proposed rules, although in some instances these technologies are still under development or not widely deployed in the current vocational vehicle fleet. Under the proposal, manufacturers would need to apply a range of technologies to their vocational chassis, which the agencies believe would be consistent with the agencies' respective statutory authorities. We are projecting that most vehicles could adopt certain of the technologies. For example, we project a 70 to 75 percent application rate for stop-start idle reduction and advanced axle lubrication. However, for other technologies, such as strong hybrids and weight reduction, we are projecting adoption rates of ten percent or less overall, with individual subcategories having adoption rates greater or less than this. The proposed standards offer manufacturers the flexibility to apply the technologies that make sense for their business and customer needs.

As discussed above, average per-vehicle costs associated with the proposed 2027 MY standards are projected to be generally less than six percent of the overall price of a new vehicle. The cost-effectiveness of these proposed vocational vehicle standards in dollars per ton is similar to the cost effectiveness estimated for light-duty trucks in the 2017–2025 light duty greenhouse gas standards, which the agencies have found to be highly cost effective.[318] In addition, the vocational vehicle standards are clearly effective from a net benefits perspective (see draft RIA Chapter 11.2). Therefore, the agencies regard the cost of the proposed standards as reasonable.

The agencies note that while the projected costs are significantly greater than the costs projected for Phase 1, we still consider these costs to be reasonable, especially given that the first vehicle owner may see the technologies pay for themselves in many cases. As discussed above, the usual period of ownership for a vocational vehicle reflects a lengthy trade cycle that may often exceed seven years. For most vehicle types evaluated, the cost of these technologies, if passed on fully to customers, would be recovered within five years or less due to the associated fuel savings, as shown in the payback analysis included in Section IX and in the draft RIA Chapter 7.1. Specifically, in Table 7–30 of the draft RIA Chapter 7.1.3, a summary is presented with estimated payback periods for each of the MOVES vocational vehicle types, using the annual vehicle miles traveled from the MOVES model for each vehicle type. As shown, the vocational vehicle type with the shortest payback would be intercity buses (less than one year), while most other vehicles (with the exception of school buses and motor homes) are projected to see paybacks in the fifth year or sooner.

The agencies note further that although the proposal is technology-forcing (especially with respect to driveline improvements) and the estimated costs for each subcategory vary considerably (by a factor of five in some cases), these costs represent only one of many possible pathways to compliance for manufacturers. Manufacturers retain leeway to develop alternative compliance paths, increasing the likelihood of the standards' successful implementation. Based on available information, the agencies believe the proposed standards are technically feasible within the lead time provided, are cost effective while accounting for the fuel savings (see draft RIA Chapter 7.1.4), and have no apparent adverse collateral potential impacts (*e.g.,* there are no projected negative impacts on safety or vehicle utility).

The proposed standards thus appear to represent a reasonable choice under Section 202(a) of the CAA and the maximum feasible under NHTSA's EISA authority at 49 U.S.C. 32902(k)(2). The agencies believe that the proposed standards are consistent with their respective authorities. Based on the information currently before the agencies, we believe that the preferred alternative would be maximum feasible and reasonable for the vocational segment with a progression of standards reaching full implementation in MY 2027.

Nevertheless, as discussed in Section I. A. (1) and in Section X (Alternatives), the agencies seek comment on the feasibility of Alternative 4, which the agencies may determine is maximum feasible and reasonable depending on comments and information received during the comment period. This alternative is discussed in detail below because it may be possible for manufacturers to accelerate product development cycles enough to reach the required levels by the 2024 model year. Thus, the agencies may conclude in the final rules that Alternative 4, or some elements of this alternative, would be maximum feasible and appropriate under CAA section 202 (a)(1) and (2), depending on information and comments received. The agencies seek comments to assist us in making that determination.

D. Alternative Vocational Vehicle Standards Considered

The agencies have analyzed vocational vehicle standards other than the proposed standards. These alternatives, listed in Table III–22, are described in detail in Section X of this preamble and the draft RIA Chapter 11.

TABLE V–23—SUMMARY OF ALTERNATIVES CONSIDERED FOR THE PROPOSED RULEMAKING

Alternative 1	No action alternative
Alternative 2	Less stringent than the proposed alternative, applying off-the-shelf technologies
Alternative 3 (Proposed Alternative)	Proposed alternative fully phased-in by MY 2027
Alternative 4	Same stringency as proposed alternative, except phasing in faster, by MY 2024
Alternative 5	More stringent alternative, based on higher adoption rates of advanced technologies

NHTSA and EPA are considering an Alternative 4 that achieves the same level of stringency as the preferred alternative, except it would provide less lead time, reaching its most stringent level three years earlier than the

[318] See Chapter 5.3 of the final RIA for the MY 2017–2025 Light-Duty GHG Rule, available at *http://www.epa.gov/otaq/climate/documents/420r12016.pdf*.

preferred alternative, that is in MY 2024. The agencies project that the same selection of technology options would be available to manufacturers regardless of what alternative is chosen. The preferred alternative would allow greater lead time to manufacturers to select and develop technologies for their vehicles.

The agencies have outstanding questions regarding relative risks and benefits of Alternative 4 due to the time frame envisioned by that alternative. If the agencies receive relevant information supporting the feasibility of Alternative 4, the agencies may consider establishing vocational vehicle standards that provide more overall reductions than what we are proposing if we deem them to be maximum feasible and reasonable for NHTSA and EPA, respectively. See the draft RIA Chapter 11.2.2 for a summary of costs and benefits that compares the proposed Phase 2 vocational vehicle program with the costs and benefits of other vocational vehicle alternatives considered.

In the paragraphs that follow, the agencies present the derivation of the Alternative 4 vocational vehicle standards. For currently developing technologies where we project an adoption rate that could present potential risks or challenges, we seek comment on the cost and effectiveness of such technology. Further, the agencies seek comment on the potential for adoption of developing technologies into the vocational vehicle fleet, as well as the extent to which the more accelerated alternative vocational vehicle standards may depend on such technology.

(1) Adoption Rates for Derivation of Alternative 4 Vocational Vehicle Standards

In developing the Alternative 4 standards, the agencies are projecting a set of technology packages in MY 2024 that is identical to those projected for the final phase-in year of the preferred alternative. Because these are the same for each subcategory, the GEM inputs modeled to derive the level of the MY 2024 Alternative 4 standards can be found in Table V–19, which presents the GEM inputs used to derive the level of the MY 2027 proposed standards. In the package descriptions below, the agencies outline technology-specific adoption rates in MY 2021 for Alternative 4 and offer insights on what market conditions could enable reaching adoption rates that would achieve the full implementation levels of stringency with less lead time.

For transmissions including hybrids, the agencies project for Alternative 4 that 50 percent of vocational vehicles would have one or more of the transmission technologies identified above in this section applied by MY 2021. This includes 25 percent deeply integrated conventional transmissions that would be recognized over the powertrain test, 10 percent DCT, 11 percent adding two gears (except zero for HHD Regional), and nine percent hybrids for vehicles certified in the Multi-Purpose and Urban subcategories, which we estimate would be five percent overall. In this alternative, the agencies project 21 percent of the vocational vehicles with manual transmissions in the HHD Regional subcategory would upgrade to either an AMT, DCT, or automatic transmission. The increased projection of driveline integration would mean that more manufacturers would need to overcome data-sharing barriers. In this alternative, we project that manufacturers would need to conduct additional research and development to achieve overall application of five percent hybrids. In the draft RIA Chapter 7.1, the agencies have estimated costs for this additional accelerated research. Comments are requested on the expected costs to accelerate hybrid development to meet the projected adoption rates of this alternative.

For advanced axle lubricants, the agencies are projecting the same 75 percent adoption rate in MY 2021 as in the proposed program. For part time or full time 6x2 axles, the agencies project the HHD Regional vocational vehicles could apply this at the 60 percent adoption rate in MY 2021, where this level wouldn't be reached until MY 2024 in the proposed program. One action that could enable this to be achieved is if information on the reliability of these systems were to be disseminated to more fleet owners by trustworthy sources.

For lower rolling resistance tires in this alternative, the agencies project the same adoption rates of LRR tires as in the proposed program for MY 2021, because we don't expect tire suppliers would be able to make greater improvements for the models that are fitted on vocational vehicles in that time frame. The tire research that is being conducted currently is focused on models for tractors and trailers, and we project further improved LRR tires would not be commercially available for vocational vehicles in the early implementation years of Phase 2.

For the adoption rate of LRR tires in MY 2024 to reach the level projected for MY 2027 in the proposed program, tire suppliers could promote their most efficient products to vocational vehicle manufacturers to achieve equivalent improvements with less lead time. Depending on how tire manufacturers focus their research and product development, it is possible that more of the LRR tire advancements being applied for tractors and trailers could be applied to vocational vehicles. To see the specific projected adoption rates of different levels of LRR tires for Alternative 4, see columns three and five of Table V–16 above.

For workday idle technologies, the agencies project an adoption rate of 12 percent stop-start in the six MHD and LHD subcategories for MY 2021 and zero for the HHD vehicles, on the expectation that manufacturers would have fewer challenges in the short term in bringing this technology to market for vehicles with lower power demands and lower engine inertia. In this alternative, the agencies project the overall workday idle adoption rate would approach 100 percent, such that any vehicle without stop-start (except HHD Regional) would apply neutral idle in MY 2021. These adoption raters consider a more aggressive investment by manufacturers in developing these technologies. Estimates of research and development costs for this alternative are presented in the draft RIA Chapter 7.1.

For weight reduction, in this alternative, the agencies project the same adoption rates of a 200-lb lightweighting package as in the proposal for each subcategory in MY 2021, which is four to seven percent. Table V–24 shows the GEM inputs used to derive the level of the Alternative 4 MY 2021 standards.

TABLE V—24—GEM INPUTS USED TO DERIVE ALTERNATIVE 4 MY 2021 VOCATIONAL VEHICLE STANDARDS

Class 2b–5			Class 6–7			Class 8		
Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Alternative 4 CI Engine [a]								
2021 MY 7L, 200 hp Engine			2021 MY 7L, 270 hp Engine			2021 MY 11L, 345 hp Engine		2021 MY 15L 455hp Engine
Transmission (improvement factor)								
0.045	0.04	0.014	0.045	0.041	0.015	0.045	0.041	0.018
Axle (improvement factor)								
0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.015
Stop-Start (adoption rate)								
12%	12%	12%	12%	12%	12%	0%	0%	0%
Neutral Idle (adoption rate)								
88%	88%	88%	88%	88%	88%	90%	90%	0%
Steer Tires (CRR kg/metric ton)								
7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Drive Tires (CRR kg/metric ton)								
7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Weight Reduction (lb)								
8	8	14	8	8	12	8	8	10

Note:
[a] SI engines were not simulated in GEM, rather a gas/diesel adjustment factor was applied to the results.

(2) Possible Alternative 4 Standards

Because the MY 2024 Alternative 4 standards are the same as the proposed standards for MY 2027 for each subcategory, these numerical standards can be found in Table V–8 and Table V–9, which present EPA's and NHTSA's proposed MY 2027 standards, respectively. Table V–25 and Table V–26 present the Alternative 4 vocational vehicle standards for the initial year of MY 2021. These represent incremental improvements over the MY 2017 baseline of six to seven percent for SI-powered vocational vehicles and nine percent for CI-powered vocational vehicles.

TABLE V–25—ALTERNATIVE 4 EPA CO_2 STANDARDS FOR MY2021 CLASS 2b–8 VOCATIONAL VEHICLES

Duty cycle	Light heavy-duty Class 2b–5	Medium heavy-duty Class 6–7	Heavy heavy-duty Class 8
Alternative EPA Standard for Vehicle with CI Engine Effective MY2021 (gram CO_2/ton-mile)			
Urban	288	183	193
Multi-Purpose	297	185	196
Regional	309	181	185
Alternative EPA Standard for Vehicle with SI Engine Effective MY2021 (gram CO_2/ton-mile)			
Urban	313	199	210
Multi-Purpose	323	201	212
Regional	336	197	201

TABLE V–26—ALTERNATIVE 4 NHTSA FUEL CONSUMPTION STANDARDS FOR MY2021 CLASS 2b–8 VOCATIONAL VEHICLES

Duty cycle	Light heavy-duty Class 2b–5	Medium heavy-duty Class 6–7	Heavy heavy-duty Class 8
Alternative NHTSA Standard for Vehicle with CI Engine Effective MY 2021 (Fuel Consumption gallon per 1,000 ton-mile)			
Urban	28.2908	17.9764	18.9587
Multi-Purpose	29.1749	18.1729	19.2534
Regional	30.3536	17.7800	18.1729
Alternative NHTSA Standard for Vehicle with SI Engine Effective MY 2021 (Fuel Consumption gallon per 1,000 ton-mile)			
Urban	35.2200	22.3923	23.6300
Multi-Purpose	36.3452	22.6173	23.8551
Regional	37.8080	22.1672	22.6173

(3) Costs Associated With Alternative 4 Standards

The agencies have estimated the costs of the technologies expected to be used to comply with the Alternative 4 standards, as shown in Table V–27 for MY2021. Fleet average costs are shown for light, medium and heavy HD vocational vehicles in each duty-cycle-based subcategory—Urban, Multi-Purpose, and Regional. As shown in Table V–27, in MY 2021 these range from approximately $800 for MHD and LHD Regional vehicles, to $4,300 for HHD Urban and Multipurpose vehicles. Those two subcategories are projected to have the higher-cost packages in MY 2021 due to an estimated 9 percent adoption of HHD hybrids, which are estimated to cost $40,000 per vehicle in MY 2021, as shown in Chapter 2.12.7 of the draft RIA. For more specific information about the agencies' estimates of per-vehicle costs, please see the draft RIA Chapter 2.12. The engine costs listed represent the cost of an average package of diesel engine technologies with Alternative 4 adoption rates described in Section II.D.2(e). The details behind all these costs are presented in draft RIA Chapter 2.12, including the markups and learning effects applied and how the costs shown here are weighted to generate an overall cost for the vocational segment.

TABLE V–27—VOCATIONAL VEHICLE TECHNOLOGY INCREMENTAL COSTS FOR ALTERNATIVE 4 STANDARDS IN THE 2021 MODEL YEAR [a] [b]

(2012$)

	Light HD			Medium HD			Heavy HD		
	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Engine [c]	$372	$372	$372	$345	$345	$345	$345	$345	$345
Tires	7	7	7	7	7	7	7	7	7
Transmission	148	148	148	148	148	148	148	148	2,042
Axle related	99	99	99	99	99	99	148	148	243
Weight Reduction	27	27	48	27	27	41	27	27	34
Idle reduction	110	110	110	116	116	116	8	8	0
Electrification & hybridization	1,384	1,384	0	2,175	2,175	0	3,633	3,633	0
Air Conditioning [d]	22	22	22	22	22	22	22	22	22
Total	2,169	2,169	805	2,938	2,938	777	4,337	4,337	2,693

Notes:

[a] Costs shown are for the 2021 model year and are incremental to the costs of a vehicle meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated vehicle classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see RIA 2.9 in particular).

[c] Engine costs are for a light HD, medium HD or heavy HD diesel engine. We are projecting no additional costs beyond Phase 1 for gasoline vocational engines.

[d] EPA's air conditioning standards are presented in Section V.C above.

The estimated costs of the technologies expected to be used to comply with the Alternative 4 standards for MY2024 are shown in Table V–28. As shown, these range from approximately $1,500 for MHD and LHD Regional vehicles to $7,900 for HHD Urban and Multipurpose vehicles. These two subcategories are projected to have the higher-cost packages in MY 2024 due to an estimated 18 percent adoption of HHD hybrids, which are estimated to cost $33,000 per vehicle in MY 2024, as shown in Chapter 2.12.7 of the draft RIA. The engine costs listed represent the cost of an average package of diesel engine technologies with Alternative 4 adoption rates described in Section II.D.2(e). For gasoline vocational vehicles, the agencies are projecting adoption of Level 2 engine friction reduction with an estimated $74 added to the average SI vocational vehicle package cost in MY 2024, which represents about 56 percent of those vehicles upgrading beyond Level 1 engine friction reduction. Further details on how these SI vocational vehicle costs were estimated are provided in the draft RIA Chapter 2.9.

TABLE V–28—VOCATIONAL VEHICLE TECHNOLOGY INCREMENTAL COSTS FOR ALTERNATIVE 4 STANDARDS IN THE 2024 MODEL YEAR [a]

(2012$)

	Light HD			Medium HD			Heavy HD		
	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional	Urban	Multi-purpose	Regional
Engine [c]	$493	$493	$493	$457	$457	$457	$457	$457	$457
Tires	26	26	26	26	26	26	40	40	40
Transmission	256	256	280	256	256	280	256	256	3,123
Axle related	90	90	90	90	90	90	136	136	224
Weight Reduction	30	30	49	30	30	43	30	30	37
Idle reduction	561	524	524	592	553	553	1,014	1,014	1,011
Electrification & hybridization	2,264	2,264	0	3,559	3,559	0	5,943	5,943	0
Air Conditioning [d]	20	20	20	20	20	20	20	20	20
Total	3,741	3,704	1,482	5,030	4,992	1,469	7,895	7,895	4,912

Notes:

[a] Costs shown are for the 2024 model year and are incremental to the costs of a vehicle meeting the Phase 1 standards. These costs include indirect costs via markups along with learning impacts. For a description of the markups and learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA (see draft RIA 2.12).

[b] Note that values in this table include adoption rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated vehicle classes. To see the actual estimated technology costs exclusive of adoption rates, refer to Chapter 2 of the draft RIA (see RIA 2.9 in particular).

[c] Engine costs shown are for a light HD, medium HD or heavy HD diesel engine. For gasoline-powered vocational vehicles we are projecting $74 of additional engine-based costs beyond Phase 1.

[d] EPA's air conditioning standards are presented in Section V.C above.

E. Compliance Provisions for Vocational Vehicles

We welcome comment on all aspects of the compliance program, including those where we would adopt a provision without change in Phase 2.

(1) Application and Certification Process

The agencies propose to continue to use GEM to determine compliance with the proposed vehicle fuel efficiency and CO_2 standards. Because the agencies are proposing to modify GEM to recognize inputs in addition to those recognized under Phase 1, there is a consequent proposed requirement that manufacturers or component suppliers conduct component testing to generate those input values. See Section II for details of engine testing and GEM inputs for engines.

As described above in Section I, the agencies propose to continue the Phase 1 compliance process in terms of the manufacturer requirements prior to the effective model year, during the model year, and after the model year. The information that would be required to be submitted by manufacturers is set forth in 40 CFR 1037.205, 49 CFR 537.6, and 49 CFR 537.7. EPA would continue to issue certificates upon approval based on information submitted through the VERIFY database (see 40 CFR 1037.255). End of year reports would continue to include the GEM results for all of the configurations built, along with credit/deficit balances, if applicable (see 40 CFR 1037.250 and 1037.730).

(a) GEM Inputs

In Phase 1, there were two inputs to GEM for vocational vehicles:

• Steer tire coefficient of rolling resistance, and
• Drive tire coefficient of rolling resistance

As discussed above in Section II and III.D, there are several additional inputs that are proposed for Phase 2. In addition to the steer and drive tire CRR, the proposed inputs include the following:

• Engine fuel map,
• Engine full-load torque curve,
• Engine motoring curve,
• Transmission type,
• Transmission gear ratios,
• Drive axle ratio,
• Loaded tire radius for drive and steer tires,
• Idle Reduction,
• Weight Reduction, and
• Other pre-defined off-cycle technologies.

(i) Driveline Inputs

As with tractors, for each engine family, an engine fuel map, full load torque curve, and motoring curve would be generated by engine manufacturers as inputs to GEM. The test procedures for the torque and motoring curves are found in proposed 40 CFR part 1065. Section II.D.1.b describes these proposed procedures as well as the proposed new procedure for generating the engine fuel map. Also similar to tractors, transmission specifications would be input to GEM. Any number of gears could be entered with a numerical ratio for each, and transmission type would be selectable as either a Manual, Automated Manual, Automatic, or Dual Clutch transmission.

As part of the driveline information needed to run GEM, drive axle ratio would be a user input. If a configuration has a two-speed axle, the agencies propose that a manufacturer may enter the ratio that is expected to be engaged most often. We request comment on whether the agencies should allow this choice. Two-speed axles are typically specified for heavy-haul vocational vehicles, where the higher numerical ratio axle would be engaged during transient driving conditions and to deliver performance needed on work sites, while the lower numerical ratio axle would be engaged during highway driving. The agencies request comment on whether we should require GEM to be run twice, once with each axle ratio, where the output over the highway cycles would be used from the run with the lower axle ratio, and the output over the transient cycle would be used from the run with the higher axle ratio.

Tire size would be a new input to GEM that is necessary for the model to simulate the performance of the vehicle.

The draft RIA Chapter 3 includes a description of how to measure tire size. For each model and nominal size of a tire, there are numerous possible sizes that could be measured, depending on whether the tire is new or ''grown,'' meaning whether it has been broken in for at least 200 miles. Size could also vary based on load and inflation levels, air temperature, and tread depth. The agencies request comment on aspects of measuring and reporting tire size that could be specified by rule, to avoid any unnecessary compliance burden of the Phase 2 program.

(ii) Idle Reduction Inputs

Based on user inputs derived from engine testing described in Section II and draft RIA Chapter 3, GEM would calculate CO_2 emissions and fuel consumption at both zero torque (neutral idle) and with torque set to Curb-Idle Transmission Torque for automatic transmissions in ''drive'' (as defined in 40 CFR 1065.510(f)(4) for variable speed engines) for use in the CO_2 emission calculation in 40 CFR 1037.510(b). The proposed regulations at 40 CFR part 1065 specify that that there must be two consecutive reference zero load idle points to establish periods of zero load idle for purposes of calculating total work over an engine test cycle. These two idle points from the engine test would be used in GEM for purposes of calculating emissions during vehicle idling over the vocational vehicle test cycles.

The agencies welcome comments on the inclusion of these technologies into GEM in Phase 2.

(iii) Weight Reduction Inputs

In Phase 1, the agencies adopted tractor regulations that provided manufacturers with the ability to utilize high strength steel and aluminum components for weight reduction without the burden of entering the curb weight of every tractor produced. In Phase 2, the agencies propose to apply relevant weights from the tractor lookup table to vocational vehicles. As noted above, the agencies are proposing to recognize weight reduction by allocating one half of the weight reduction to payload in the denominator, while one half of the weight reduction would be subtracted from the overall weight of the vehicle in GEM.

To adapt the tractor table for vocational vehicles, the agencies propose to add lookup values for vehicles in lower weight classes. We believe it is appropriate to also recognize the weight reduction associated with 6x2 axles.[319] Components available for vocational vehicle manufacturers to select for weight reduction are shown below in Table V–29, below. We are also proposing to assign a fixed weight increase to natural gas fueled vehicles to reflect the weight increase of natural gas fuel tanks versus gasoline or diesel tanks. These are shown as negative values in Table V–29 to indicate that GEM would internally compute these values in an inverse manner as would be computed for a weight reduction, for which the GEM input is a positive numerical value. We welcome comments on all aspects of weight reduction approaches and potential weight increases as a byproduct of technology application.

TABLE V—29 PROPOSED PHASE 2 WEIGHT REDUCTION TECHNOLOGIES FOR VOCATIONAL VEHICLES

<table>
<tr><th rowspan="2">Component</th><th rowspan="2">Material</th><th colspan="3">Vocational Vehicle Class</th></tr>
<tr><th>Class 2b–5</th><th>Class 6–7</th><th>Class 8</th></tr>
<tr><td>Axle Hubs—Non-Drive</td><td>Aluminum</td><td colspan="2">40</td><td>40</td></tr>
<tr><td>Axle Hubs—Non-Drive</td><td>High Strength Steel</td><td colspan="2">5</td><td>5</td></tr>
<tr><td>Axle—Non-Drive</td><td>Aluminum</td><td colspan="2">60</td><td>60</td></tr>
<tr><td>Axle—Non-Drive</td><td>High Strength Steel</td><td colspan="2">15</td><td>15</td></tr>
<tr><td>Brake Drums—Non-Drive</td><td>Aluminum</td><td colspan="2">60</td><td>60</td></tr>
<tr><td>Brake Drums—Non-Drive</td><td>High Strength Steel</td><td colspan="2">8</td><td>8</td></tr>
<tr><td>Axle Hubs—Drive</td><td>Aluminum</td><td colspan="2">40</td><td>80</td></tr>
<tr><td>Axle Hubs—Drive</td><td>High Strength Steel</td><td colspan="2">10</td><td>20</td></tr>
<tr><td>Brake Drums—Drive</td><td>Aluminum</td><td colspan="2">70</td><td>140</td></tr>
<tr><td>Brake Drums—Drive</td><td>High Strength Steel</td><td colspan="2">5.5</td><td>11</td></tr>
<tr><td>Clutch Housing</td><td>Aluminum</td><td colspan="2">34</td><td>40</td></tr>
<tr><td>Clutch Housing</td><td>High Strength Steel</td><td colspan="2">9</td><td>10</td></tr>
<tr><td>Suspension Brackets, Hangers</td><td>Aluminum</td><td colspan="2">67</td><td>100</td></tr>
<tr><td>Suspension Brackets, Hangers</td><td>High Strength Steel</td><td colspan="2">20</td><td>30</td></tr>
<tr><td>Transmission Case</td><td>Aluminum</td><td colspan="2">45</td><td>50</td></tr>
<tr><td>Transmission Case</td><td>High Strength Steel</td><td colspan="2">11</td><td>12</td></tr>
<tr><td>Crossmember—Cab</td><td>Aluminum</td><td>10</td><td>14</td><td>15</td></tr>
<tr><td>Crossmember—Cab</td><td>High Strength Steel</td><td>2</td><td>4</td><td>5</td></tr>
<tr><td>Crossmember—Non-Suspension</td><td>Aluminum</td><td>15</td><td>18</td><td>21</td></tr>
<tr><td>Crossmember—Non-Suspension</td><td>High Strength Steel</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Crossmember—Suspension</td><td>Aluminum</td><td>15</td><td>20</td><td>25</td></tr>
<tr><td>Crossmember—Suspension</td><td>High Strength Steel</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>Driveshaft</td><td>Aluminum</td><td>12</td><td>40</td><td>50</td></tr>
<tr><td>Driveshaft</td><td>High Strength Steel</td><td>5</td><td>10</td><td>12</td></tr>
<tr><td>Frame Rails</td><td>Aluminum</td><td>120</td><td>300</td><td>440</td></tr>
<tr><td>Frame Rails</td><td>High Strength Steel</td><td>24</td><td>40</td><td>87</td></tr>
<tr><td>Wheels—Dual</td><td>Aluminum</td><td>126</td><td>126</td><td>210</td></tr>
<tr><td>Wheels—Dual</td><td>High Strength Steel</td><td>48</td><td>48</td><td>80</td></tr>
<tr><td>Wheels—Dual</td><td>Lightweight Aluminum</td><td>180</td><td>180</td><td>300</td></tr>
<tr><td>Wheels—Wide Base Single</td><td>Aluminum</td><td>278</td><td>278</td><td>556</td></tr>
<tr><td>Wheels—Wide Base Single</td><td>High Strength Steel</td><td>168</td><td>168</td><td>336</td></tr>
<tr><td>Wheels—Wide Base Single</td><td>Lightweight Aluminum</td><td>294</td><td>294</td><td>588</td></tr>
</table>

[319] See NACFE Confidence Findings on the Potential of 6x2 Axles, Note 152 above.

TABLE V—29 PROPOSED PHASE 2 WEIGHT REDUCTION TECHNOLOGIES FOR VOCATIONAL VEHICLES—Continued

Component	Material	Vocational Vehicle Class		
		Class 2b–5	Class 6–7	Class 8
Permanent 6x2 Axle Configuration	Multi	N/A	N/A	300
CI Liquified Natural Gas Vocational Vehicle	Multi	[320] [321] −600		
SI Compressed Natural Gas Vocational Vehicle	Multi	−525		
CI Compressed Natural Gas Vocational Vehicle	Multi	−900		

(b) Test Procedures

Powertrain families aredefined in Section II.C.3.b, and powertrain test procedures are discussed in the draft RIA Chapter 3. The agencies propose that the results from testing a powertrain configuration using the matrix of tests described in draft RIA Chapter 3.6 could be applied broadly across all vocational vehicles in which that powertrain would be installed.

As in Phase 1, the rolling resistance of each tire would be measured using the ISO 28850 test method for drive tires and steer tires planned for fitment to the vehicle being certified. Once the test CRR values are obtained, a manufacturer would input the CRR values for the drive and steer tires separately into the GEM. For vocational vehicles in Phase 2, the agencies propose that the vehicle load would be distributed with 30 percent of the load over the steer tires and 70 percent of the load over the drive tires. With these data entered, the amount of GHG reduction attributed to tire rolling resistance would be incorporated into the overall vehicle compliance value.

(c) Useful Life and In-Use Standards

Section 202(a)(1) of the CAA specifies that emission standards are to be applicable for the useful life of the vehicle. The standards that EPA and NHTSA are proposing would apply to individual vehicles and engines at production and in use. NHTSA is not proposing in-use standards for vehicles and engines.

Manufacturers may be required to submit, as part of the application for certification, an engineering analysis showing that emission control performance will not deteriorate during the useful life, with proper maintenance. If maintenance will be required to prevent or minimize deterioration, a demonstration may be required that this maintenance will be performed in use. See 40 CFR 1037.241.

EPA is proposing to continue the Phase 1 approach to adjustment factors and deterioration factors. The technologies on which the Phase 1 vocational vehicle standards were predicated were not expected to have any deterioration of GHG effectiveness in use. However, the regulations provided a process for manufacturers to develop deterioration factors (DF) if they needed. We anticipate that some hybrid powertrain systems may experience some deterioration of effectiveness with age of the energy storage device. We believe the regulations in place currently provide adequate instructions to manufacturers for developing DF where needed. We request comment on whether any changes to the DF process are needed.

As with engine certification, a manufacturer must provide evidence of compliance through the regulatory useful life of the vehicle. Factors influencing vehicle-level GHG performance over the life of the vehicle fall into two basic categories: Vehicle attributes and maintenance items. Each category merits different treatment from the perspective of assessing useful life compliance, as each has varying degrees of manufacturer versus owner/operator responsibility.

For vocational vehicles, attributes generally refers to components that are installed by the manufacturer to meet the standard, whose reduction properties are assessed at the time of certification, and which are expected to last the full life of the vehicle with effectiveness maintained as new for the life of the vehicle with no special maintenance requirements. To assess useful life compliance, we are proposing to follow a design-based approach that would ensure that the manufacturer has robustly designed these features so they can reasonably be expected to last the useful life of the vehicle.

For vocational vehicles, maintenance items generally refers to items that are replaced, renewed, cleaned, inspected, or otherwise addressed in the preventative maintenance schedule specified by the vehicle manufacturer. Replacement items that have a direct influence on GHG emissions are primarily tires and lubricants, but may also include hybrid system batteries. Synthetic engine oil may be used by vehicle manufacturers to reduce the GHG emissions of their vehicles. Manufacturers may specify that these fluids be changed throughout the useful life of the vehicle. If this is the case, the manufacturer should have a reasonable basis that the owner/operator will use fluids having the same properties. This may be accomplished by requiring (in service documentation, labeling, etc.) that only these fluids can be used as replacements. In this proposal, the only maintenance costs we have quantified are those for tire replacement, as described in Section IX.C.3 and the draft RIA Chapter 7.1. The agencies invite comments with information related to maintenance costs that the agencies should quantify for the final rules.

For current non-hybrid technologies, if the vehicle remains in its original certified condition throughout its useful life, it is not believed that GHG emissions would increase as a result of service accumulation. As in Phase 1, the agencies propose allowing the use of an assigned deterioration factor of zero where appropriate in Phase 2; however this does not negate the responsibility of the manufacturer to ensure compliance with the emission standards throughout the useful life. The vehicle manufacturer would be primarily responsible for providing engineering analysis demonstrating that vehicle attributes will last for the full useful life of the vehicle. We anticipate this demonstration would show that components are constructed of sufficiently robust materials and design practices so as not to become dysfunctional under normal operating conditions.

In Phase 1, EPA set the useful life for engines and vehicles with respect to GHG emissions equal to the respective useful life periods for criteria pollutants. In April 2014, as part of the Tier 3 light-duty vehicle final rule, EPA extended the regulatory useful life period for criteria pollutants to 150,000 miles or 15 years, whichever comes first, for Class

[320] See National Energy Policy Institute (2012), Note 200 above.

[321] See Westport presentation (2013), Note 201, above.

2b and 3 pickup trucks and vans and some light-duty trucks (79 FR 23414, April 28, 2014). Class 2 through Class 5 heavy-duty vehicles subject to the GHG standards described in this section for vocational applications generally use the same kinds of engines, transmissions, and emission controls as the Class 2b and 3 vehicles that are chassis-certified to the criteria standards under 40 CFR part 86, subpart S. EPA and NHTSA are therefore proposing that the Phase 2 GHG and fuel consumption standards for vocational vehicles at or below 19,500 lbs GVWR apply over the same useful life of 150,000 miles or 15 years. In many cases, this will result in aligned useful-life values for criteria and GHG standards. Where this longer useful life is not aligned with the useful life that applies for criteria standards (generally in the case of engine-based certification under 40 CFR part 86, subpart A), EPA may revisit the useful-life values for both criteria and GHG standards in a future rulemaking. For medium heavy-duty vehicles (19,500 to 33,000 lbs GVWR) and heavy heavy-duty vehicles (above 33,000 lbs GVWR) EPA is proposing to keep the useful-life values from Phase 1, which are 185,000 miles (or 10 years) and 435,000 miles (or 10 years), respectively. EPA requests comment on this approach, including the proposed values and the overall process envisioned for achieving the long-term goal of adopting harmonized useful-life specifications for criteria and GHG standards that properly represent the manufacturers' obligation to meet emission standards over the expected service life of the vehicles. EPA may also revisit the useful-life values that apply for medium heavy-duty vehicles and heavy heavy-duty vehicles.

One technology option for vocational vehicle manufacturers to reduce GHG emissions is to use a smaller engine, perhaps in conjunction with a hybrid powertrain. This could lead to a situation where the engine and the vehicle are subject to emission standards over different useful-life periods. For example, an urban bus (heavy heavy-duty vehicle), might be able to use a medium heavy-duty engine, or even a light heavy-duty engine. While such a mismatch in useful life values could be confusing, we don't believe it poses any particular policy problem that we need to address. EPA requests comment on the possibility of mismatched engine and vehicle useful-life values and on any possible implications this may have for manufacturers' ability to design, certify, produce, and sell their engines and vehicles.

(d) Assigning Vehicles to Test Cycles

The agencies propose the following logic for deciding which chassis configurations would be assigned to each of the three proposed vocational duty cycles and thus regulatory subcategories:

- A vehicle would be certified over the Multipurpose Duty Cycle, unless one of the following conditions warrants certifying over either the Regional or Urban cycle.
- If the vehicle is powered by a CI engine, use the Regional Duty Cycle if the resulting value from the calculation described in Equation V–1 is less than 75 percent.
- If the vehicle is powered by a SI engine, use the Regional Duty Cycle if the resulting value from the calculation described in Equation V–1 is less than 45 percent.

Equation V-1 Proposed Regional Duty Cycle Cutpoint

$$Cutpoint\ Regional = \left(\frac{65\ mph\ x\ axle\ ratio\ x\ trans\ ratio\ x\ C}{SLR * fntest}\right) x100$$

Where:

$Cutpoint_{Regional}$ is the percent of maximum engine test speed that is achieved at a vehicle speed of 65 mph,

SLR is the static loaded tire radius entered into GEM as specified in the regulations,

Axle ratio is the drive axle ratio that entered into GEM as specified in the regulations,

Trans ratio is the ratio of the top transmission gear that is not permanently locked out,

f_{ntest} is the maximum engine test speed as defined at 40 CFR 1065.610, and C is a constant equal to:

$$\frac{5280\frac{ft}{mi}x\ 12\frac{in}{ft}x\ .0254\frac{m}{in}}{60\frac{min}{hr}x\ 2\pi}$$

- If a vehicle is powered by a CI engine, use the Urban Duty Cycle if the resulting value from the calculation described in Equation V–2 is greater than 90 percent.
- If a vehicle is powered by a SI engine, use the Urban Duty Cycle if the resulting value from the calculation described in Equation V–2 is greater than 50 percent.

Equation V-2 Proposed Urban Duty Cycle Cutpoint

$$Cutpoint\ Urban = \left(\frac{55\ mph\ x\ axle\ ratio\ x\ trans\ ratio\ x\ C}{SLR * fntest}\right) x100$$

Where:

$Cutpoint_{Urban}$ is the percent of maximum engine test speed that is achieved at a vehicle speed of 55 mph,

SLR is the static loaded tire radius entered into GEM as specified in the regulations,

Axle ratio is the drive axle ratio that is entered into GEM as specified in the regulations,

Trans ratio is the ratio of the top transmission gear that is not permanently locked out,

f_{ntest} is the maximum engine test speed as defined at 40 CFR 1065.610, and C is a constant equal to:

$$\frac{5280\frac{ft}{mi}\,x\;12\frac{in}{ft}\,x\;.0254\frac{m}{in}}{60\frac{min}{hr}\,x\;2\pi}$$

The agencies ran GEM with many vocational vehicle configurations to develop a data set with which we could assess appropriate cutpoints for the above equations. The configurations varied primarily by the engine model, fuel type, and axle ratio. See the draft RIA Chapter 2.9.2 for further details on the assessment process for these proposed cutpoints.

The agencies realize that there are vocational vehicles for which the above logic may not result in an appropriate assignment of test cycle. Therefore we are proposing an exception that would enable any vehicle with a hybrid drivetrain to certify over the Urban test cycle. Further, we are proposing that the following vehicles must be certified using the Regional cycle: intercity coach buses, recreational vehicles, and vehicles whose engine is exclusively certified over the SET. We are also proposing to allow manufacturers to request a different duty cycle. We request comment on this approach, and whether we should allow manufacturers to have complete freedom to select a test cycle without any need for EPA or NHTSA approval.

(2) Other Compliance Provisions

(a) Emission Control Labels

The agencies consider it crucial that authorized compliance inspectors are able to identify whether a vehicle is certified, and if so whether it is in its certified condition. To facilitate this identification in Phase 1, EPA adopted labeling provisions for vocational vehicles that included several items. The Phase 1 vocational vehicle label must include the manufacturer, vehicle identifier such as the Vehicle Identification Number, vehicle family, regulatory subcategory, date of manufacture, compliance statements, and emission control system identifiers (see 40 CFR 1037.135). In Phase 1, the vocational vehicle emission control system identifier is tire rolling resistance, plus any innovative and advanced technologies.

The number of proposed emission control systems for greenhouse gas emissions in Phase 2 has increased significantly. For example, the engine, transmission, axle configuration, tire radius, and idle reduction system are control systems that can be evaluated on-cycle in Phase 2 (*i.e.* these technologies' performance can now be input to GEM), but could not be evaluated in Phase 1. Due to the complexity in determining greenhouse gas emissions as proposed in Phase 2, the agencies do not believe that we can unambiguously determine whether or not a vehicle is in a certified condition through simply comparing information that could be made available on an emission control label with the components installed on a vehicle. Therefore, EPA proposes to remove the requirement to include the emission control system identifiers required in 40 CFR 1037.135(c)(6) and in Appendix III to 40 CFR part 1037 from the emission control labels for vocational vehicles certified to the primary Phase 2 standards. However, the agencies may finalize requirements to maintain some label content to facilitate a limited visual inspection of key vehicle parameters that can be readily observed. Such requirements may be very similar to the labeling requirements from the Phase 1 rulemaking, though we would want to more carefully consider the list of technologies that would allow for the most effective inspection. We request comment on an appropriate list of candidate technologies that would properly balance the need to limit label content with the interest in providing the most useful information for inspectors to confirm that vehicles have been properly built. EPA is not proposing to modify the existing emission control labels for vocational vehicles certified for MYs 2014–2020 (Phase 1) CO_2 standards.

Under the agencies' existing authorities, manufacturers must provide detailed build information for a specific vehicle upon our request. Our expectation is that this information should be available to us via email or other similar electronic communication on a same-day basis, or within 24 hours of a request at most. We request comment on any practical limitations in promptly providing this information. We also request comment on approaches that would minimize burden for manufacturers to respond to requests for vehicle build information and would expedite an authorized compliance inspector's visual inspection. For example, the agencies have started to explore ideas that would provide inspectors with an electronic method to identify vehicles and access on-line databases that would list all of the engine-specific and vehicle-specific emissions control system information. We believe that electronic and Internet technology exists today for using scan tools to read a bar code or radio frequency identification tag affixed to a vehicle that would then lead to secure on-line access to a database of manufacturers' detailed vehicle and engine build information. Our exploratory work on these ideas has raised questions about the level of effort that would be required to develop, implement and maintain an information technology system to provide inspectors real-time access to this information. We have also considered questions about privacy and data security. We request comment on the concept of electronic labels and database access, including any available information on similar systems that exist today and on burden estimates and approaches that could address concerns about privacy and data security. Based on new information that we receive, we may consider initiating a separate rulemaking effort to propose and request comment on implementing such an approach.

(b) End of Year Reports

In the Phase 1 program, manufacturers participating in the ABT program provided 90 day and 270 day reports to EPA and NHTSA after the end of the model year. The agencies adopted two reports for the initial program to help manufacturers become familiar with the reporting process. For the HD Phase 2 program, the agencies propose to simplify reporting such that manufacturers would only be required to submit one end of the year report 120 days after the end of the model year with the potential to obtain approval for a delay up to 30 days. We welcome comment on this proposed revision.

(c) Delegated Assembly

The proposed standards for vocational vehicles are based on the application of a wide range of technologies. Certifying vehicle manufacturers manage their compliance demonstration to reflect this range of technologies by describing their certified configurations in the application for certification. In many cases, these technologies are designed and assembled (or installed) directly by the certifying vehicle manufacturer, which is typically the chassis manufacturer. In these cases, it is straightforward to assign the responsibility to the certifying vehicle manufacturer for ensuring that vehicles are in their proper certified configuration when sold to the ultimate user. In Phase 1, the only vehicle technology available for certified vocational vehicles was LRR tires. Because these are generally installed by the chassis manufacturer, there would have been no need to rely on a second stage manufacturer for purposes of certification.

In Phase 2, the agencies are considering certain technologies where the certifying vehicle manufacturer may want or need to rely on a downstream manufacturing company (a secondary vehicle manufacturer) to take steps to assemble or install certain components or technologies to bring the vehicle into a certified configuration. A similar relationship between manufacturers applies with aftertreatment devices for certified engines. EPA has adopted ''delegated assembly'' provisions for engines at 40 CFR 1068.261 to describe how manufacturers can share compliance responsibilities through these cooperative assembly procedures.

We are proposing to take a similar approach for vehicle-based GHG standards in 40 CFR part 1037. The delegated assembly provisions as proposed for GHG standards are focused on add-on features to reduce aerodynamic drag, and on air conditioning systems. This may occur, for example, if the certifying manufacturer sells a cab-complete chassis to a secondary vehicle manufacturer, which in turn installs a box with the appropriate aerodynamic accessories to reduce drag losses. To the extent certifying manufacturers rely on secondary vehicle manufacturers to bring the vehicle into a certified configuration, the following provisions would apply:

- The certifying manufacturer would describe their approach to delegated assembly in the application for certification.
- The certifying manufacturer would create installation instructions to describe how the secondary vehicle manufacturer would bring the vehicle into a certified configuration.
- The certifying manufacturer would have a contractual agreement with each affected secondary vehicle manufacturer obligating the secondary vehicle manufacturer to build each vehicle into a certified configuration and to provide affidavits confirming proper assembly procedures, and to provide information regarding deployment of each type of technology (if there are technology options that relate to different GEM input values).

The delegated assembly provisions are most relevant to vocational vehicles, but we are not proposing to limit these provisions to vocational vehicles. Similarly, we expect that aerodynamic devices and air conditioning systems are the most likely technologies for which delegated assembly is appropriate, but we are not proposing to limit the use of delegated assembly to these technologies.

Secondary manufacturers (such as body builders) that build complete vehicles from certified chassis are obligated to comply with the emission-related installation instructions provided by the certifying manufacturer. Secondary manufacturers that build complete vehicles from exempted chassis are obligated to comply with all of the regulations.

The draft regulations at 40 CFR 1037.621 describe further detailed provisions related to delegated assembly. We request comment on all aspects of these provisions. In particular, we request comment on how the procedures should be applied more broadly or more narrowly for specific technologies. We also request comment on any further modifications that should be made to the delegated assembly provisions to reflect the nature of manufacturing relationships or technologies that are specific to greenhouse gas standards for heavy-duty highway vehicles.

(d) Demonstrating Compliance With Proposed HFC Leakage Standards

EPA is proposing requirements for vocational chassis manufacturers to demonstrate reductions in direct emissions of HFC in their A/C systems and components through a design-based method. The method for calculating A/C leakage is the same as was adopted in Phase 1 for tractors and HD pickups and vans. It is based closely on an industry-consensus leakage scoring method, described below. This leakage scoring method is correlated to experimentally-measured leakage rates from a number of vehicles using the different available A/C components. As is done currently for other HD vehicles, vocational chassis manufacturers would choose from a menu of A/C equipment and components used in their vehicles in order to establish leakage scores, to characterize their A/C system leakage performance. The percent leakage per year would then be calculated as this score divided by the system refrigerant capacity.

Consistent with the light-duty rule and the Phase 1 program for other HD vehicles, EPA is proposing a requirement that vocational chassis manufacturers compare the components of a vehicle's A/C system with a set of leakage-reduction technologies and actions that is based closely on that developed through the Improved Mobile Air Conditioning program and SAE International (as SAE Surface Vehicle Standard J2727, ''HFC–134a, Mobile Air Conditioning System Refrigerant Emission Chart,'' August 2008 version). *See* generally 75 FR 25426. The SAE J2727 approach was developed from laboratory testing of a variety of A/C related components, and EPA believes that the J2727 leakage scoring system generally represents a reasonable correlation with average real-world leakage in new vehicles. This approach associates each component with a specific leakage rate in grams per year that is identical to the values in J2727 and then sums together the component leakage values to develop the total A/C system leakage. Unlike the light-duty program, in the heavy-duty vehicle program, the total A/C leakage score is divided by the value of the total refrigerant system capacity to develop a percent leakage per year. EPA believes that the design-based approach results in estimates of likely leakage emissions reductions that are comparable to those that would result from performance-based testing.

Consistent with HD GHG Phase 1, EPA is not proposing a specific in-use standard for leakage, as neither test procedures nor facilities exist to measure refrigerant leakage from a vehicle's air conditioning system. However, consistent with the HD Phase 1 program and the light-duty rule, where we propose to require that manufacturers attest to the durability of components and systems used to meet the CO_2 standards (see 75 FR 25689), we propose to require that manufacturers of heavy-duty vocational vehicles attest to the durability of these systems, and provide an engineering analysis that demonstrates component and system durability.

(e) Glider Vehicles

EPA is proposing to not exempt glider vehicles from the Phase 2 GHG emission and fuel consumption standards.[322] Gliders and glider kits are exempt from NHTSA's Phase 1 fuel consumption standards. EPA's interim provisions of Phase 1 exempted glider vehicles produced by small businesses from the Phase 1 CO_2 emission standards but did not include such a blanket exemption for other glider vehicles.[323] Thus, some glider vehicles are already subject to the requirement to obtain a vehicle certificate prior to introduction into commerce as a new vehicle. However, the agencies believe glider manufacturers may not understand how these regulations apply to them, resulting in a number of uncertified vehicles.

EPA is concerned about adverse economic impacts on small businesses that assemble glider kits and glider vehicles. Therefore, EPA is proposing a new provision that would grandfather existing small businesses, but cap annual production based on recent sales. This approach is consistent with the approach recommended by the Small Business Advocacy Review Panel, which believed there should be an allowance to produce some glider vehicles for legitimate purposes. EPA requests comment on whether any special provisions would be needed to accommodate glider vehicles. See Section XIV.B for additional discussion of the proposed requirements for glider vehicles.

Similarly, NHTSA is considering including gliders under its Phase 2 program. The agencies request comment on their respective considerations. We believe that the agencies potentially having different policies for glider kits and glider vehicles under the Phase 2 program would not result in problematic disharmony between the NHTSA and EPA programs, because of the small number of vehicles that would be involved. EPA believes that its proposed changes would result in the glider market returning to the pre-2007 levels, in which fewer than 1,000 glider vehicles would be produced in most years. Given that a large fraction of these vehicles would be exempted from EPA regulations because they would be produced by qualifying small businesses, they would thus, in practice, be treated the same under EPA and NHTSA regulations. Only non-exempt glider vehicles would be subject to different requirements under the NHTSA and EPA regulations. However, we believe that this is unlikely to exceed a few hundred vehicles in any year, which would be few enough not to result in any meaningful disharmony between the two agencies.

With regard to NHTSA's safety authority over gliders, the agency notes that it has become increasingly aware of potential noncompliance with its regulations applicable to gliders. NHTSA has learned of manufacturers who are creating glider vehicles that are new vehicles under 49 CFR 571.7(e); however, the manufacturers are not certifying them and obtaining a new VIN as required. NHTSA plans to pursue enforcement actions as applicable against noncompliant manufacturers. In addition to enforcement actions, NHTSA may consider amending 49 CFR 571.7(e) and related regulations as necessary in the future. NHTSA believes manufacturers may not be using this regulation as originally intended.

(3) Proposed Compliance Flexibility Provisions

EPA and NHTSA are proposing three flexibility provisions specifically for vocational vehicle manufacturers in Phase 2. These are an averaging, banking and trading program for CO_2 emissions and fuel consumption credits, provisions for off-cycle credits for technologies that are not included as inputs to the GEM, and optional chassis certification. The agencies are also proposing to remove or modify several Phase 1 interim provisions, as described below. Program-wide compliance flexibilities are discussed in Section I.B.3 to I.C.1.

(a) Averaging, Banking, and Trading (ABT) Program

Averaging, banking, and trading of emission credits have been an important part of many EPA mobile source programs under CAA Title II. ABT provisions provide manufacturers flexibilities that assist in the efficient development and implementation of new technologies and therefore enable new technologies to be implemented at a more aggressive pace than without ABT. NHTSA and EPA propose to carry-over the Phase 1 ABT provisions for vocational vehicles into Phase 2, as it is an important way to achieve each agency's programmatic goals. ABT is also discussed in Section I and Section III.F.1.

Consistent with the Phase 1 averaging sets, the agencies propose that chassis manufacturers may average SI-powered vocational vehicle chassis with CI-powered vocational vehicle chassis, within the same vehicle weight class group. In Phase 1, all vocational and tractor chassis within a vehicle weight class group were able to average with each other, regardless of whether they were powered by a CI or SI engine. The proposed Phase 2 approach would continue this. The only difference is that in Phase 2, there would be different numerical standards set for the SI-powered and CI-powered vehicles, but that would not need to alter the basis for averaging. This is consistent with the Phase 1 approach where, for example, Class 8 day cab tractors, Class 8 sleeper cab tractors and Class 8 vocational vehicles each have different numerical standards, while they all belong to the same averaging set.

As discussed in V. E. (1) (c), EPA and NHTSA are proposing to change the useful life for LHD vocational vehicles for GHG emissions from the current 10 years/110,000 miles to 15 years/150,000 miles to be consistent with the useful life of criteria pollutants recently updated in EPA's Tier 3 rule. For the same reasons, EPA and NHTSA are also proposing a useful life adjustment for HD pickups and vans, as described in Section VI.E.(1). According to the credits calculation formula at 40 CFR 1037.705 and 49 CFR 535.7, useful life in miles is a multiplicative factor included in the calculation of CO_2 and fuel consumption credits. In order to ensure that banked credits would maintain their value in the transition from Phase 1 to Phase 2, NHTSA and EPA propose an interim vocational vehicle adjustment factor of 1.36 for credits that are carried forward from Phase 1 to the MY 2021 and later Phase 2 standards.[324] Without this adjustment factor the proposed change in useful life would effectively result in a discount of banked credits that are carried forward from Phase 1 to Phase 2, which is not the intent of the change in the useful life. The agencies do not believe that this proposed adjustment would result in a loss of program benefits because

[322] Glider vehicles are new vehicles produced to accept rebuilt engines (or other used engines) along with used axles and/or transmissions. The common term ''glider kit'' is used here primarily to refer to an assemblage of parts into which the used/rebuilt engine is installed.

[323] Rebuilt engines used in glider vehicles are subject to EPA criteria pollutant emission standards applicable for the model year of the engine. See 40 CFR 86.004–40 for requirements that apply for engine rebuilding. Under existing regulations, engines that remain in their certified configuration after rebuilding may continue to be used.

[324] See 40 CFR 1037.150(s) and 49 CFR 535.7.

there is little or no deterioration anticipated for CO_2 emissions and fuel consumption over the life of the vehicles. Also, the carry-forward of credits is an integral part of the program, helping to smoothing the transition to the new Phase 2 standards. The agencies believe that effectively discounting carry-forward credits from Phase 1 to Phase 2 would be unnecessary and could negatively impact the feasibility of the proposed Phase 2 standards. EPA and NHTSA request comment on all aspects of the averaging, banking, and trading program.

(b) Innovative and Off-Cycle Technology Credits

In Phase 1, the agencies adopted an emissions and fuel consumption credit generating opportunity that applied to innovative technologies that reduce fuel consumption and CO_2 emissions. These technologies were required to not be in common use with heavy-duty vehicles before the 2010MY and not reflected in the GEM simulation tool (*i.e.,* the benefits are ''off-cycle''). See 76 FR 57253. The agencies propose to largely continue the Phase 1 innovative technology program but to redesignate it as an off-cycle program for Phase 2. The agencies propose to maintain that, in order for a manufacturer to receive credits for Phase 2, the off-cycle technology would still need to meet the requirement that it was not in common use prior to MY 2010.

The agencies recognize that there are emerging technologies today that are being developed, but would not be accounted for in the GEM tool, and therefore would be considered off-cycle. These technologies could include systems such as electrified accessories, air conditioning system efficiency, and aerodynamics for vocational vehicles beyond those tested and pre-approved in the HD Phase 2 program. Such off-cycle technologies could include known, commercialized technologies if they are not yet widely utilized in a particular heavy-duty sector subcategory. Any credits for these technologies would need to be based on real-world fuel consumption and GHG reductions that can be measured with verifiable test methods using representative driving conditions typical of the engine or vehicle application. More information about off-cycle technology credits can be found at Section I.C.1.c.

As in Phase 1, the agencies are proposing to continue to provide two paths for approval of the test procedure to measure the CO_2 emissions and fuel consumption reductions of an off-cycle technology used in vocational vehicles. See 40 CFR 1037.610 and 49 CFR 535.7. The first path would not require a public approval process of the test method. A manufacturer could use ''pre-approved'' test methods for HD vehicles including the A-to-B chassis testing, powerpack testing or on-road testing. A manufacturer may also use any developed test procedure that has known quantifiable benefits. A test plan detailing the testing methodology would be required to be approved prior to collecting any test data. The agencies are also proposing to continue the second path, which includes a public approval process of any testing method that could have questionable benefits (*i.e.,* an unknown usage rate for a technology). Furthermore, the agencies are proposing to modify their provisions to clarify what documentation must be submitted for approval, which would align them with provisions in 40 CFR 86.1869–12. NHTSA is separately proposing to prohibit credits from technologies addressed by any of its crash avoidance safety rulemakings (*i.e.,* congestion management systems). See also 77 FR 62733 (discussion of similar issue in the light duty greenhouse gas/ fuel economy regulations). We welcome recommendations on how to improve or streamline the off-cycle technology approval process.

There are some technologies that are entering the market today, and although our model does not have the capability to simulate the effectiveness over the test cycles, there are reliable estimates of effectiveness available to the agencies. These are proposed to be recognized in our HD Phase 2 certification procedures as pre-defined technologies, and would not be considered off-cycle. Examples of such technologies for vocational vehicles include 6x2 axles and axle lubricants. These default effectiveness values would be used as valid inputs to GEM. The projected effectiveness of each vocational vehicle technology is discussed in the draft RIA Chapter 2.9.

The agencies propose that the approval for Phase 1 innovative technology credits (approved prior to 2021 MY) would be carried into the Phase 2 program on a limited basis for those technologies where the benefit is not accounted for in the Phase 2 test procedure. Therefore, the manufacturers would not be required to request new approval for any innovative credits carried into the off-cycle program, but would have to demonstrate the new cycle does not account for these improvements beginning in the 2021 MY. The agencies believe this is appropriate because technologies, such as those related to the transmission or driveline, may no longer be ''off-cycle'' because of the addition of these technologies into the Phase 2 version of GEM. The agencies also seek comments on whether off-cycle technologies in the Phase 2 program should be limited by infrequent common use and by what model years, if any. We also seek comments on an appropriate penetration rate for a technology not to be considered in common use.

(c) Optional Chassis Certification

In Phase 2, the agencies are proposing to continue the Phase 1 provisions allowing the optional chassis certification of vehicles over 14,000 lbs GVWR. In Phase 1 the agencies allowed manufacturers the option to choose to comply with heavy-duty pickup or van standards, for incomplete vehicles that were identical to those on complete pickup truck or van counterparts, with respect to most components that affect GHG emissions and fuel consumption, such as engines, cabs, frames, transmissions, axles, and wheels. The incomplete vehicles would typically be produced as cab-complete vehicles. For example, a manufacturer could certify under this allowance an incomplete pickup truck that includes the cab, but not the bed. The Phase 1 program also includes provisions that allow manufacturers to include some Class 4 and Class 5 vehicles in averaging sets subject to the chassis-based HD pickup and van standards, rather than the vocational vehicle program.[325]

This optional chassis certification of vehicles over 14,000 lbs applies for greenhouse gas emission standards in Phase 1, but not for criteria pollutant emission standards. We revisited this issue in the recent Tier 3 final rule, where we revised the regulation to allow this same flexibility relative to exhaust emission standards for criteria pollutants. However, EPA is now seeking comment on the proper approach for certifying vehicles above 14,000 lbs GVWR, because there are lingering questions about how best to align the certification processes for GHG emissions and for criteria pollutants. The agencies are requesting comment on several issues on this topic, including whether there should be an upper weight limit to this allowance. See Section XIV.A.2 for the issues on which the agencies seek comment with respect to chassis and engine certification for GHG and criteria pollutants for vehicles opting into the HD pickup and van program.

[325] See 76 FR 57259–57260, September 15, 2011 and 78 FR 36374, June 17, 2013.

(d) Phase 1 Flexibilities Not Proposed for Phase 2

As described above in Section I, the agencies are not proposing to provide advanced technology credits in Phase 2. These technologies had been defined in Phase 1 as hybrid powertrains, Rankine cycle engines, all-electric vehicles, and fuel cell vehicles (see 40 CFR 1037.150(i)), at a 1.5 credit value with the purpose to promote the early implementation of advanced technologies that were not expected to be widely adopted in the market in the 2014 to 2018 time frame. Our feasibility assessment for the proposed Phase 2 vocational vehicle standards includes a projection of the use of hybrid powertrains as described earlier in this section; therefore the agencies believe it would no longer be appropriate to provide extra credit for this technology. As noted above, waste heat recovery is not projected to be utilized for vocational vehicles within the time frame of Phase 2. While the agencies are not proposing to premise the Phase 2 vocational vehicle standards on fuel cells or electric vehicles, we expect that any vehicle certified with this technology would provide such a large credit to a manufacturer that an additional incentive credit would not be necessary. We welcome comments on the need for such incentives, including information on why an incentive for specific technologies in this time frame may be warranted, recognizing that the incentive would result in reduced benefits in terms of CO_2 emissions and fuel use due to the Phase 2 program.

The agencies are not proposing to extend early credits to manufacturers who comply early with Phase 2 standards, because the ABT program from Phase 1 will be available to manufacturers and this displaces the need for early credits (see 40 CFR 1037.150(a)). Please see the more complete discussion of this above in Section I.

Another Phase 1 interim flexibility that the agencies are not proposing to continue in Phase 2 is the flexibility known as the ''loose engine'' provision, whereby SI engines sold to chassis manufacturers and intended for use in vocational vehicles need not meet the separate SI engine standard (see preamble Section II and draft RIA Chapter 2.6), and instead may be averaged with the manufacturer's HD pickup and van fleet. We believe the benefits this particular flexibility offers for manufacturers in the interim between Phase 1 and Phase 2 would diminish considerably in Phase 2. The agencies are proposing a Phase 2 SI engine standard that is no more stringent than the MY 2016 SI engine standard adopted in Phase 1, while the proposed Phase 2 standards for the HD pickup and van fleet would be progressively more stringent through MY 2027. The primary certification path designed in the Phase 1 program for both CI and SI engines sold separately and intended for use in vocational vehicles was that they be engine certified while the vehicle would be GEM certified under the GHG rules. In Phase 2 the agencies propose to continue this as the certification path for such engines intended for vocational vehicles. See the draft RIA Chapter 2.6 for further discussion of the separate engine standard for SI engines intended for vocational vehicles.

(e) Other Phase 1 Interim Provisions

In HD Phase 1, EPA adopted provisions to delay the onboard diagnostics (OBD) requirements for heavy-duty hybrid powertrains (see 40 CFR 86.010–18(q)). This provision delayed full OBD requirements for hybrids until MY 2016 and MY 2017. In discussion with manufacturers during the development of Phase 2, the agencies have learned that meeting the on-board diagnostic requirements for criteria pollutant engine certification continues to be a potential impediment to adoption of hybrid systems. See Section XIII.A.1 for a discussion of regulatory changes proposed to reduce the non-GHG certification burden for engines paired with hybrid powertrain systems.

Also in Phase 1, EPA adopted provisions that reinforced the fact that we were setting GHG emissions from the tailpipe of heavy-duty vehicles. Therefore, we treated all electric vehicles as having zero emissions of CO_2, CH_4, and N_2O (see 40 CFR 1037.150(f)). Similarly, NHTSA adopted regulations in Phase 1 that set the fuel consumption standards based on the fuel consumed by the vehicle. The agencies also did not require emission testing for electric vehicles in Phase 1. The agencies considered the potential unintended consequence of ignoring upstream emissions from the charging of heavy-duty battery-electric vehicles. In our assessment, we have observed that the few all-electric heavy-duty vocational vehicles that have been certified are being produced in very small volumes in MY2014. As we look to the future, we project very limited adoption of electric vocational vehicles into the market; therefore, we believe that this provision is still appropriate. Unlike the MY2012–2016 light-duty rule, which adopted a cap whereby upstream emissions would be counted after a certain volume of sales (see 75 FR 25434–25436), we believe there is no need to propose a cap for vocational vehicles because of the infrequent projected use of EV technologies in the Phase 2 timeframe. In Phase 2, we propose to continue to deem electric vehicles as having zero CO_2, CH_4, and N_2O emissions as well as zero fuel consumption. We welcome comments on this approach.

VI. Heavy-Duty Pickups and Vans

A. Introduction and Summary of Phase 1 HD Pickup and Van Standards

In the Phase 1 rule, EPA and NHTSA established GHG and fuel consumption standards and a program structure for complete Class 2b and 3 heavy-duty vehicles (referred to in these rules as ''HD pickups and vans''), as described below. The Phase 1 standards began to be phased-in in MY 2014 and the agencies believe the program is working well. The agencies are proposing to retain most elements from the structure of the program established in the Phase 1 rule for the Phase 2 program while proposing more stringent Phase 2 standards for MY 2027, phased in over MYs 2021–2027, that would require additional GHG reductions and fuel consumption improvements. The MY 2027 standards would remain in place unless and until amended by the agencies.

Heavy-duty vehicles with GVWR between 8,501 and 10,000 lb are classified in the industry as Class 2b motor vehicles. Class 2b includes vehicles classified as medium-duty passenger vehicles (MDPVs) such as very large SUVs. Because MDPVs are frequently used like light-duty passenger vehicles, they are regulated by the agencies under the light-duty vehicle rules. Thus the agencies did not adopt additional requirements for MDPVs in the Phase 1 rule and are not proposing additional requirements for MDPVs in this rulemaking. Heavy-duty vehicles with GVWR between 10,001 and 14,000 lb are classified as Class 3 motor vehicles. Class 2b and Class 3 heavy-duty vehicles together emit about 15 percent of today's GHG emissions from the heavy-duty vehicle sector.

About 90 percent of HD pickups and vans are ¾-ton and 1-ton pickup trucks, 12- and 15-passenger vans, and large work vans that are sold by vehicle manufacturers as complete vehicles, with no secondary manufacturer making substantial modifications prior to registration and use. Most of these vehicles are produced by companies with major light-duty markets in the

United States, primarily Ford, General Motors, and Chrysler. Often, the technologies available to reduce fuel consumption and GHG emissions from this segment are similar to the technologies used for the same purpose on light-duty pickup trucks and vans, including both engine efficiency improvements (for gasoline and diesel engines) and vehicle efficiency improvements.

In the Phase 1 rule EPA adopted GHG standards for HD pickups and vans based on the whole vehicle (including the engine), expressed as grams of CO_2 per mile, consistent with the way these vehicles are regulated by EPA today for criteria pollutants. NHTSA adopted corresponding gallons per 100 mile fuel consumption standards that are likewise based on the whole vehicle. This complete vehicle approach adopted by both agencies for HD pickups and vans was consistent with the recommendations of the NAS Committee in its 2010 Report. EPA and NHTSA adopted a structure for the Phase 1 HD pickup and van standards that in many respects paralleled long-standing NHTSA CAFE standards and more recent coordinated EPA GHG standards for manufacturers' fleets of new light-duty vehicles. These commonalities include a new vehicle fleet average standard for each manufacturer in each model year and the determination of these fleet average standards based on production volume-weighted targets for each model, with the targets varying based on a defined vehicle attribute. Vehicle testing for both the HD and light-duty vehicle programs is conducted on chassis dynamometers using the drive cycles from the EPA Federal Test Procedure (Light-duty FTP or ''city'' test) and Highway Fuel Economy Test (HFET or ''highway'' test).[326]

For the light-duty GHG and fuel economy [327] standards, the agencies factored in vehicle size by basing the emissions and fuel economy targets on vehicle footprint (the wheelbase times the average track width).[328] For those standards, passenger cars and light trucks with larger footprints are assigned higher GHG and lower fuel economy target levels in acknowledgement of their inherent tendency to consume more fuel and emit more GHGs per mile. EISA requires that NHTSA study ''the appropriate metric for measuring and expressing commercial medium- and heavy-duty vehicle and work truck fuel efficiency performance, taking into consideration, among other things, the work performed by such on-highway vehicles and work trucks . . .'' See 49 U.S.C. 32902(k)(1)(B).[329] For HD pickups and vans, the agencies also set standards based on vehicle attributes, but used a work-based metric as the attribute rather than the footprint attribute utilized in the light-duty vehicle rulemaking. Work-based measures such as payload and towing capability are key among the parameters that characterize differences in the design of these vehicles, as well as differences in how the vehicles will be utilized. Buyers consider these utility-based attributes when purchasing a HD pickup or van. EPA and NHTSA therefore finalized Phase 1 standards for HD pickups and vans based on a ''work factor'' attribute that combines the vehicle's payload and towing capabilities, with an added adjustment for 4-wheel drive vehicles. See generally 76 FR 57161–57162.

For Phase 1, the agencies adopted provisions such that each manufacturer's fleet average standard is based on production volume-weighting of target standards for all vehicles that in turn are based on each vehicle's work factor. These target standards are taken from a set of curves (mathematical functions). The Phase 1 curves are shown in the figures below for reference and are described in detail in the Phase 1 final rule.[330] The agencies established separate curves for diesel and gasoline HD pickups and vans. The agencies are proposing to continue to use the work-based attribute and gradually declining standards approach for the Phase 2 standards, as discussed in Section VI.B. below. Note that this approach does not create an incentive to reduce the capabilities of these vehicles because less capable vehicles are required to have proportionally lower emissions and fuel consumption targets.

[326] The Light-duty FTP is a vehicle driving cycle that was originally developed for certifying light-duty vehicles and subsequently applied to HD chassis testing for criteria pollutants. This contrasts with the Heavy-duty FTP, which refers to the transient engine test cycles used for certifying heavy-duty engines (with separate cycles specified for diesel and spark-ignition engines).

[327] Light duty fuel *economy* standards are expressed as miles per gallon (mpg), which is inverse to the HD fuel *consumption* standards which are expressed as gallons per 100 miles.

[328] EISA requires CAFE standards for passenger cars and light trucks to be attribute-based; *See* 49 U.S.C. 32902(b)(3)(A).

[329] The NAS 2010 report likewise recommended standards recognizing the work function of HD vehicles. See 76 FR 57161.

[330] The Phase 1 Final Rule provides a full discussion of the standard curves including the equations and coefficients. See 76 FR 57162–57165, September 15 2011. The standards are also provided in the regulations at 40 CFR 1037.104 (which is proposed to be redesignated as 40 CFR 86.1819–14).

[331] The NHTSA program provides voluntary standards for model years 2014 and 2015. Target line functions for 2016–2018 are for the second NHTSA alternative described in the Phase 1 preamble Section II.C (d)(ii).

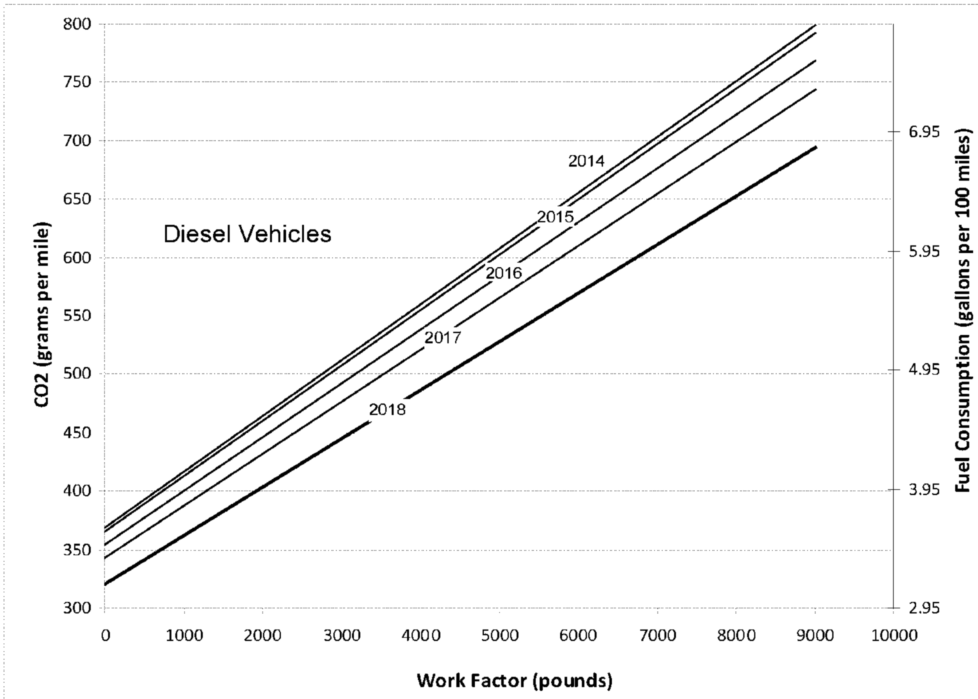

Figure VI-1 EPA Phase 1 CO_2 Target Standards and NHTSA Fuel Consumption Target Standards for Diesel HD Pickups and Vans[331]

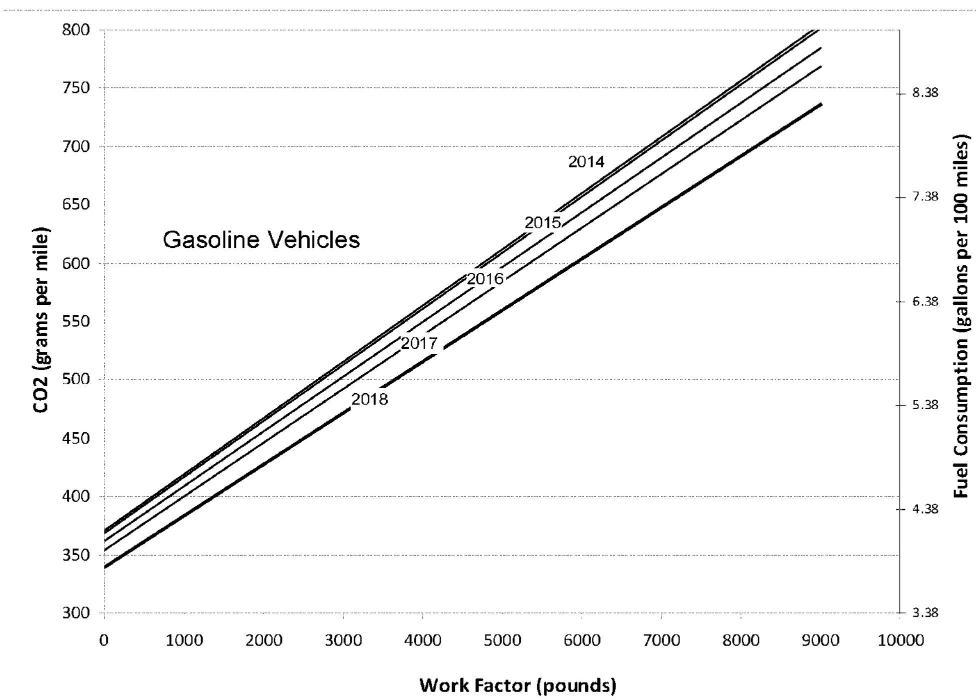

Figure VI-2 EPA Phase 1 CO_2 Target Standards and NHTSA Fuel Consumption Target Standards for Gasoline HD Pickups and Vans

EPA phased in its CO_2 standards gradually starting in the 2014 model year, at 15–20–40–60–100 percent of the model year 2018 standards stringency level in model years 2014–2015–2016–2017–2018, respectively. The phase-in takes the form of the set of target standard curves shown above, with increasing stringency in each model year. The final EPA Phase 1 standards for 2018 (including a separate standard to control air conditioning system leakage) represent an average per-vehicle reduction in GHGs of 17 percent for diesel vehicles and 12 percent for gasoline vehicles, compared to a common MY 2010 baseline. EPA also finalized a compliance alternative whereby manufacturers can phase in different percentages: 15–20–67–67–67–100 percent of the model year 2019 standards stringency level in model years 2014–2015–2016–2017–2018–2019, respectively. This compliance alternative parallels and is equivalent to NHTSA's first alternative described below.

NHTSA's Phase 1 program allows manufacturers to select one of two fuel consumption standard alternatives for model years 2016 and later. The first alternative defines individual gasoline vehicle and diesel vehicle fuel consumption target curves that will not change for model years 2016–2018, and are equivalent to EPA's 67–67–67–100 percent target curves in model years 2016–2017–2018–2019, respectively. This option is consistent with EISA requirements that NHTSA provide 4 years lead-time and 3 years of stability for standards. See 49 U.S.C. 32902 (k)(3). The second alternative uses target curves that are equivalent to EPA's 40–60–100 percent target curves in model years 2016–2017–2018, respectively. Stringency for the alternatives in Phase 1 was selected by the agencies to allow a manufacturer, through the use of the credit carry-forward and carry-back provisions that the agencies also finalized, to meet both NHTSA fuel efficiency and EPA GHG emission standards using a single compliance strategy. If a manufacturer cannot meet an applicable standard in a given model year, it may make up its shortfall by over-complying in a subsequent year. NHTSA also allows manufacturers to voluntarily opt into the NHTSA HD pickup and van program in model years 2014 or 2015. For these model years, NHTSA's fuel consumption target curves are equivalent to EPA's target curves. The Phase 1 phase-in options are summarized in Table VI–1.

TABLE VI–1—PHASE 1 STANDARDS PHASE-IN OPTIONS

	2014 %	2015 %	2016 %	2017 %	2018 %	2019 %
EPA Primary Phase-in	15	20	40	60	100	100
EPA Compliance Option	15	20	67	67	67	100
NHTSA First Option	0	0	67	67	67	100
NHTSA Second Option	0	0	40	60	100	100

The form and stringency of the Phase 1 standards curves are based on the performance of a set of vehicle, engine, and transmission technologies expected (although not required) to be used to meet the GHG emissions and fuel economy standards for model year 2012–2016 light-duty vehicles, with full consideration of how these technologies are likely to perform in heavy-duty vehicle testing and use. All of these technologies are already in use or have been announced for upcoming model years in some light-duty vehicle models, and some are in use in a portion of HD pickups and vans as well. The technologies include:

- advanced 8-speed automatic transmissions
- aerodynamic improvements
- electro-hydraulic power steering
- engine friction reductions
- improved accessories
- low friction lubricants in powertrain components
- lower rolling resistance tires
- lightweighting
- gasoline direct injection
- diesel aftertreatment optimization
- air conditioning system leakage reduction (for EPA program only)

B. Proposed HD Pickup and Van Standards

As described in this section, NHTSA and EPA are proposing more stringent MY 2027 and later Phase 2 standards that would be phased in over model years 2021–2027. The agencies are proposing standards based on a year-over-year increase in stringency of 2.5 percent over MYs 2021–2027 for a total increase in stringency for the Phase 2 program of about 16 percent compared to the MY 2018 Phase 1 standard. Note that an individual manufacturer's fleet-wide target may differ from this stringency increase due to changes in vehicle sales mix and changes in work factor. The agencies have analyzed several alternatives which are discussed in this section below and in Section X. In particular, we are requesting comment not only on the proposed standards but also particularly on the Alternative 4 standard which would result in approximately the same Phase 2 program stringency increase of about 16 percent compared to Phase 1 but would do so two years earlier, in MY 2025 rather than in MY 2027. The Alternative 4 phase in from 2021–2025 would be based on a year-over-year increase in stringency of 3.5 percent, as discussed below. While we believe the proposed preferred alternative is feasible in the time frame of this rule, and that Alternative 4 could potentially be feasible, the two phase-in schedules differ in the required adoption rate of advanced technologies for certain high volume vehicle segments. The agencies' analysis essentially shows that the additional lead-time provided by the preferred alternative would allow manufacturers to more fully utilize lower cost technologies thereby reducing the adoption rate of more advanced higher cost technologies such as strong hybrids. As discussed in more detail in C.8 below, both of the considered phase-ins require comparable penetration rates of several non-hybrid technologies with some approaching 100 percent penetration. However, as discussed below, the additional lead-time provided by Alternative 3 would allow manufacturers more flexibility to fully utilize these non-hybrid technologies to reduce the number of hybrids needed compared to Alternative 4. Alternative 4 would additionally require significant penetration of strong hybridization. We request comments, additional information, data, and feedback to determine the extent to which such adoption would be realistic within the MY 2025 timeframe.

When considering potential Phase 2 standards, the agencies anticipate that the technologies listed above that were considered in Phase 1 will continue to be available in the future if not already applied under Phase 1 standards and that additional technologies will also be available:

- advanced engine improvements for friction reduction and low friction lubricants
- improved engine parasitics, including fuel pumps, oil pumps, and coolant pumps
- valvetrain variable lift and timing
- cylinder deactivation
- direct gasoline injection
- cooled exhaust gas recirculation
- turbo downsizing of gasoline engines
- Diesel engine efficiency improvements
- downsizing of diesel engines
- 8-speed automatic transmissions
- electric power steering

- high efficiency transmission gear boxes and driveline
- further improvements in accessory loads
- additional improvements in aerodynamics and tire rolling resistance
- low drag brakes
- mass reduction
- mild hybridization
- strong hybridization

Sections VI.C. and D below and Section 2 of the Draft RIA provide a detailed analysis of these and other potential technologies for Phase 2, including their feasibility, costs, and effectiveness and projected application rates for reducing fuel consumption and CO_2 emissions when utilized in HD pickups and vans. Sections VI.C and D and Section X also discuss the selection of the proposed standards and the alternatives considered.

In addition to EPA's CO_2 emission standards and NHTSA's fuel consumption standards for HD pickups and vans, EPA in Phase 1 also finalized standards for two additional GHGs—N_2O and CH_4, as well as standards for air conditioning-related HFC emissions in the Phase 1 rule. EPA is proposing to continue these standards in Phase 2. Also, consistent with CAA Section 202(a)(1), EPA finalized Phase 1 standards that apply to HD pickups and vans in use and EPA is proposing in-use standards for these vehicles in Phase 2. All of the proposed standards for these HD pickups and vans are discussed in more detail below. Program flexibilities and compliance provisions related to the standards for HD pickups and vans are discussed in Section VI.E.

A relatively small number of HD pickups and vans are sold by vehicle manufacturers as incomplete vehicles, without the primary load-carrying device or container attached. A sizeable subset of these incomplete vehicles, often called cab-chassis vehicles, are sold by the vehicle manufacturers in configurations with complete cabs and many of the components that affect GHG emissions and fuel consumption identical to those on complete pickup truck or van counterparts—including engines, cabs, frames, transmissions, axles, and wheels. The Phase 1 program includes provisions that allow manufacturers to include these incomplete vehicles as well as some Class 4 through 6 vehicles to be regulated under the chassis-based HD pickup and van program (*i.e.* subject to the standards for HD pickups and vans), rather than the vocational vehicle program.[332] The agencies are proposing to continue allowing such incomplete vehicles the option of certifying under either the heavy duty pickup and van standards or the standards for vocational vehicles.

Phase 1 also includes optional compliance paths for spark-ignition engines identical to engines used in heavy-duty pickups and vans to comply with 2b/3 standards. See 40 CFR 1037.150(m) and 49 CFR 535.5(a)(7). Manufacturers sell such engines as ''loose engines'' or install these engines in incomplete vehicles that are not cab-complete vehicles. The agencies are not proposing to retain the loose engine provisions for Phase 2. These program elements are discussed above in Section V.E. on vocational vehicles and XIV.A.2 on engines.

NHTSA and EPA request comment on all aspects of the proposed HD pickup and van standards and program elements described below and the alternatives discussed in Section X.

(1) Vehicle-Based Standards

For Phase 1, EPA and NHTSA chose to set vehicle-based standards whereby the entire vehicle is chassis-tested. The agencies propose to retain this approach for Phase 2. About 90 percent of Class 2b and 3 vehicles are pickup trucks, passenger vans, and work vans that are sold by the original equipment manufacturers as complete vehicles, ready for use on the road. In addition, most of these complete HD pickups and vans are covered by CAA vehicle emissions standards for criteria pollutants (*i.e.,* they are chassis tested similar to light-duty), expressed in grams per mile. This distinguishes this category from other, larger heavy-duty vehicles that typically have engines covered by CAA engine emission standards for criteria pollutants, expressed in grams per brake horsepower-hour. As a result, Class 2b and 3 complete vehicles share both substantive elements and a regulatory structure much more in common with light-duty trucks than with the other heavy-duty vehicles.

Three of these features in common are especially significant: (1) Over 95 percent of the HD pickups and vans sold in the United States are produced by Ford, General Motors, and Chrysler—three companies with large light-duty vehicle and light-duty truck sales in the United States; (2) these companies typically base their HD pickup and van designs on higher sales volume light-duty truck platforms and technologies, often incorporating new light-duty truck design features into HD pickups and vans at their next design cycle, and (3) at this time most complete HD pickups and vans are certified to vehicle-based rather than engine-based EPA criteria pollutant and GHG standards. There is also the potential for substantial GHG and fuel consumption reductions from vehicle design improvements beyond engine changes (such as through optimizing aerodynamics, weight, tires, and accessories), and a single manufacturer is generally responsible for both engine and vehicle design. All of these factors together suggest that it is still appropriate and reasonable to base standards on performance of the vehicle as a whole, rather than to establish separate engine and vehicle GHG and fuel consumption standards, as is being done for the other heavy-duty categories. The chassis-based standards approach for complete vehicles was also consistent with NAS recommendations and there was consensus in the public comments on the Phase 1 proposal supporting this approach. For all of these reasons, the agencies continue to believe that establishing chassis-based standards for Class 2b and 3 complete vehicles is appropriate for Phase 2.

(a) Work-Based Attributes

In developing the Phase 1 HD rulemaking, the agencies emphasized creating a program structure that would achieve reductions in fuel consumption and GHGs based on how vehicles are used and on the work they perform in the real world. Work-based measures such as payload and towing capability are key among the things that characterize differences in the design of vehicles, as well as differences in how the vehicles will be used. Vehicles in the 2b and 3 categories have a wide range of payload and towing capacities. These work-based differences in design and in-use operation are key factors in evaluating technological improvements for reducing CO_2 emissions and fuel consumption. Payload has a particularly important impact on the test results for HD pickup and van emissions and fuel consumption, because testing under existing EPA procedures for criteria pollutants and the Phase 1 standards is conducted with the vehicle loaded to half of its payload capacity (rather than to a flat 300 lb as in the light-duty program), and the correlation between test weight and fuel use is strong.

Towing, on the other hand, does not directly factor into test weight as nothing is towed during the test. Hence, setting aside any interdependence between towing capacity and payload,

[332] See 76 FR 57259–57260, September 15, 2011 and 78 FR 36374, June 17, 2013.

only the higher curb weight caused by any heavier truck components would play a role in affecting measured test results. However towing capacity can be a significant factor to consider because HD pickup truck towing capacities can be quite large, with a correspondingly large effect on vehicle design.

We note too that, from a purchaser perspective, payload and towing capability typically play a greater role than physical dimensions in influencing purchaser decisions on which heavy-duty vehicle to buy. For passenger vans, seating capacity is of course a major consideration, but this correlates closely with payload weight.

For these reasons, EPA and NHTSA set Phase 1 standards for HD pickups and vans based on a ''work factor'' attribute that combines vehicle payload capacity and vehicle towing capacity, in lbs, with an additional fixed adjustment for four-wheel drive (4wd) vehicles. This adjustment accounts for the fact that 4wd, critical to enabling many off-road heavy-duty work applications, adds roughly 500 lb to the vehicle weight. The work factor is calculated as follows: 75 percent maximum payload + 25 percent of maximum towing + 375 lbs if 4wd. Under this approach, target GHG and fuel consumption standards are determined for each vehicle with a unique work factor (analogous to a target for each discrete vehicle footprint in the light-duty vehicle rules). These targets will then be production weighted and summed to derive a manufacturer's annual fleet average standard for its heavy-duty pickups and vans. There was widespread support (and no opposition) for the work factor-based approach to standards and fleet average approach to compliance expressed in the comments we received on the Phase 1 rule. The agencies are proposing to continue using the work factor attribute for the Phase 2 standards and request comments on continuing this approach.

Recognizing that towing is not reflected in the certification test for these vehicles, however, the agencies are requesting comment with respect to the treatment of towing in the work factor, especially for diesel vehicles. More specifically, does using the existing work factor equation create an inappropriate incentive for manufacturers to provide more towing capability than needed for some operators, or a disincentive for manufacturers to develop vehicles with intermediate capability. In other words, does it encourage ''surplus'' towing capability that has no value to vehicle owners and operators? We recognize that some owners and operators do actually use their vehicles to tow very heavy loads, and that some owners and operators who rarely use their vehicles to tow heavy loads nonetheless prefer to own vehicles capable of doing so. However, others may never tow such heavy loads and purchase their vehicles for other reasons, such as cargo capacity or off-road capability. Some of these less demanding (in terms of towing) users may choose to purchase gasoline-powered vehicles that are typically less expensive and have lower GCWR values, an indicator of towing capability. However, others could prefer a diesel engine more powerful than today's gasoline engines but less powerful than the typical diesel engines found in 2b and 3 pickups today. In this context, the agencies are considering (but have not yet evaluated) four possible changes to the work factor and how it is applied. First, the agencies are considering revising the work factor to weight payload by 80 percent and towing by 20 percent. Second, we are considering capping the amount of towing that could be credited in the work factor. For example, the work factors for all vehicles with towing ratings above 15,000 lbs could be calculated based on a towing rating of 15,000 lbs. It is important to be clear that such a provision would not limit the towing capability manufacturers could provide, but would only impact the extent to which the work factor would ''reward'' towing capability. Third, the agencies are considering changing the shape of the standard curve for diesel vehicles to become more flat at very high work factors. A flatter curve would mean that vehicles with very high work factors would be more similar to vehicles with lower work factors than is the case for the proposed curve. Thus, conceptually, flattening the curves at the high end might be appropriate if we were to determine that these high work factor vehicles actually operate in a manner more like the vehicles with lower work factors. For example, when not towing and when not hauling a full payload, heavy-duty pickup trucks with very different work factors may actually be performing the same amount of work. Finally, we are considering having different work factor formulas for pickups and vans, and are also further considering whether any of other changes should be applied differently to pickups than to vans. We welcome comments on both the extent to which surplus towing may be an issue and whether any of the potential changes discussed above would be appropriate. Commenters supporting such changes are encouraged to also address any potential accompanying changes. For example, if we reweight the work factor, would other changes to the coefficients defining the target curves be important to ensure that standards remain at the maximum feasible levels. (Commenters should, however, recognize that average requirements will, in any event, depend on fleet mix, and the agencies expect to update estimates of future fleet mix before issuing a final rule).

As noted in the Phase 1 rule, the attribute-based CO_2 and fuel consumption standards are meant to be as consistent as practicable from a stringency perspective. Vehicles across the entire range of the HD pickup and van segment have their respective target values for CO_2 emissions and fuel consumption, and therefore all HD pickups and vans will be affected by the standard. With this attribute-based standards approach, EPA and NHTSA believe there should be no significant effect on the relative distribution of vehicles with differing capabilities in the fleet, which means that buyers should still be able to purchase the vehicle that meets their needs.

(b) Standards

The agencies are proposing Phase 2 standards based on analysis performed to determine the appropriate HD pickup and van Phase 2 standards and the most appropriate phase in of those standards. This analysis, described below and in the Draft RIA, considered:

- Projections of future U.S. sales for HD pickup and vans
- the estimates of corresponding CO_2 emissions and fuel consumption for these vehicles
- forecasts of manufacturers' product redesign schedules
- the technology available in new MY 2014 HD pickups and vans to specify preexisting technology content to be included in the analysis fleet (the fleet of vehicles used as a starting point for analysis) extending through MY 2030
- the estimated effectiveness, cost, applicability, and availability of technologies for HD pickup and vans
- manufacturers' ability to use credit carry-forward
- the levels of technology that are projected to be added to the analysis fleet through MY 2030 considering improvements needed in order to achieve compliance with the Phase 1 standards (thus defining the reference fleet–*i.e.,* under the No-Action Alternative—relative to which to measure incremental impacts of Phase 2 standards), and
- the levels of technology that are projected to be added to the analysis fleet through MY2030 considering

further improvements needed in order to achieve compliance with standards defining each regulatory (action) alternative for Phase 2.

Based on this analysis, EPA is proposing CO_2 attribute-based target standards shown in Figure VI–3 and Figure VI–4, and NHTSA is proposing the equivalent attribute-based fuel consumption target standards, also shown in Figure VI–3 and Figure VI–4, applicable in model year 2021–2027. As shown in these tables, these standards would be phased in year-by-year commencing in MY 2021. The agencies are not proposing to change the standards for 2018–2020 and therefore the standards would remain stable at the MY 2018 Phase 1 levels for MYs 2019 and 2020. EISA requires four years of lead-time and three years stability for NHTSA standards and this period of lead-time and stability for 2018–2020 is consistent with the EISA requirements. For MYs 2021–2027, the agencies are proposing annual reductions in the standards as the primary phase-in of the Phase 2 standards. The proposed standards become 16 percent more stringent overall between MY 2020 and MY 2027. This approach to the Phase 2 standards as a whole can be considered a phase-in or implementation schedule of the proposed MY 2027 standards (which, as noted, would apply thereafter unless and until amended).

For EPA, Section 202(a) provides the Administrator with the authority to establish standards, and to revise those standards ''from time to time,'' thus providing the Administrator with considerable discretion in deciding when to revise the Phase 1 MY 2018 standards. EISA requires that NHTSA provide four full model years of regulatory lead time and three full model years of regulatory stability for its fuel economy standards. See 49 U.S.C. 32902(k)(3). Consistent with these authorities, the agencies are proposing more stringent standards beginning with MY 2021 that consider the level of technology we predict can be applied to new vehicles in the 2021 MY. EPA believes the proposed Phase 2 standards are consistent with CAA requirements regarding lead-time, reasonable cost, and feasibility, and safety. NHTSA believes the proposed Phase 2 standards are the maximum feasible under EISA. Manufacturers in the HD pickup and van market segment have relatively few vehicle lines and redesign cycles are typically longer compared to light-duty vehicles. Also, the timing of vehicle redesigns differs among manufacturers. To provide lead time needed to accommodate these longer redesign cycles, the proposed Phase 2 GHG standards would not reach their highest stringency until 2027. Although the proposed standards would become more stringent over time between MYs 2021 and 2027, the agencies expect manufacturers will likely strive to make improvements as part of planned redesigns, such that some model years will likely involve significant advances, while other model years will likely involve little change. The agencies also expect manufacturers to use program flexibilities (*e.g.,* credit carry-forward provisions and averaging, banking, and trading provisions) to help balance compliance costs over time (including by allowing needed changes to align with redesign schedules). The agencies are proposing to provide stable standards in MYs 2019–2020 in order to provide necessary lead time for Phase 2. However, for some manufacturers, the transition to the Phase 2 standards may begin earlier (*e.g.,* as soon as MY 2017) depending on their vehicle redesign cycles. Although standards are not proposed to change in MYs 2019–2020, manufacturers may introduce additional technologies in order to carry forward corresponding improvements and perhaps generate credits under the 5 year credit carry-forward provisions established in Phase 1 and proposed to continue for Phase 2. Sections VI.C. and D below provides additional discussion of vehicle redesign cycles and the feasibility of the proposed standards.

While it is unlikely that there is a phase-in approach that would equally fit with all manufacturers' unique product redesign schedules, the agencies recognize that there are other ways the Phase 2 standards could be phased in and request comments on other possible approaches. One alternative approach would be to phase in the standards in a few step changes, for example in MYs 2021, 2024 and 2027. Under this example, if the step changes on the order of 5 percent, 10 percent, and 16 percent improvements from the MY 2020 baseline in MYs 2021, 2024 and 2027 respectively, the program would provide CO_2 reductions and fuel improvements roughly equivalent to the proposed approach. Among the factors the agencies would consider in assessing a different phase-in than that proposed would be impacts on lead time, feasibility, cost, CO_2 reductions and fuel consumption improvements. The agencies request that commenters consider all of these factors in their recommendations on phase-in.

As in Phase 1, the proposed Phase 2 standards would be met on a production-weighted fleet average basis. No individual vehicle would have to meet a particular fleet average standard. Nor would all manufacturers have to meet numerically identical fleet average requirement. Rather, each manufacturer would have its own unique fleet average requirement based on the production-weighted average of the heavy duty pickups and vans it chooses to produce. Moreover, averaging, banking, and trading provisions, just alluded to and discussed further below, would provide significant additional compliance flexibility in implementing the standards. It is important to note, however, that while the standards would differ numerically from manufacturer to manufacturer, effective stringency should be essentially the same for each manufacturer.

Also, as with the Phase 1 standards, the agencies are proposing separate Phase 2 targets for gasoline-fueled (and any other Otto-cycle) vehicles and diesel-fueled (and any other diesel-cycle) vehicles. The targets would be used to determine the production-weighted fleet average standards that apply to the combined diesel and gasoline fleet of HD pickups and vans produced by a manufacturer in each model year. The above-proposed stringency increase for Phase 2 applies equally to the separate gasoline and diesel targets. The agencies considered different rates of increase for the gasoline and diesel targets in order to more equally balance compliance burdens across manufacturers with varying gasoline/diesel fleet mixes. However, at least among major HD pickup and van manufacturers, our analysis suggests limited potential for such optimization, especially considering uncertainties involved with manufacturers' future fleet mix. The agencies have thus maintained the equivalent rates of stringency increase. The agencies invite comment on this element.

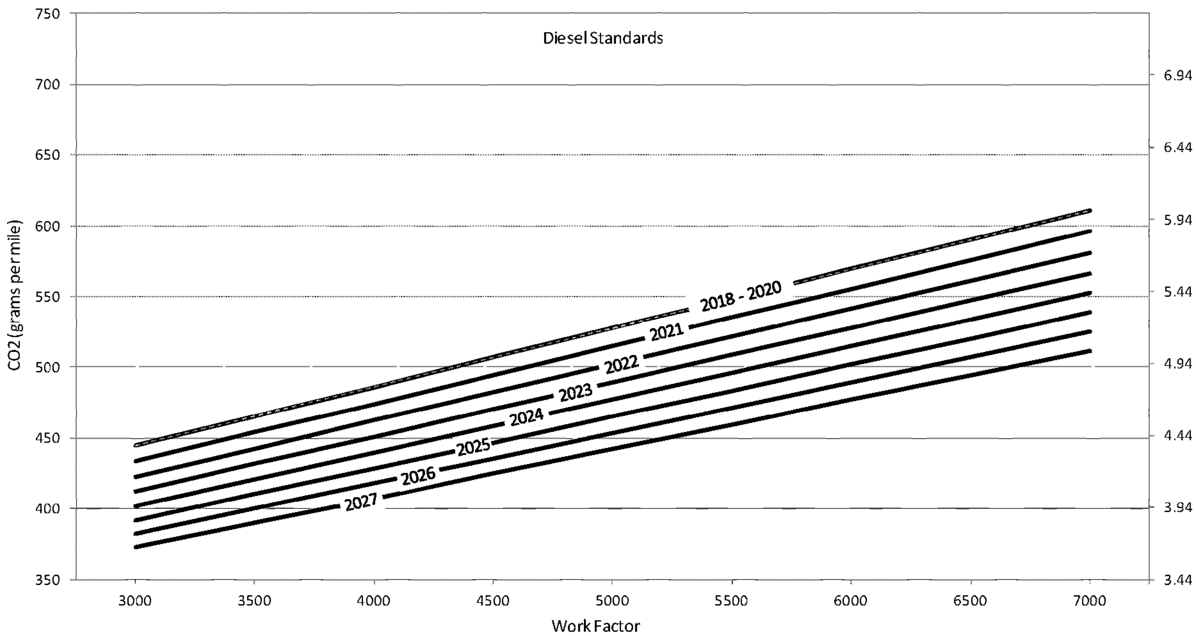

Figure VI-3 EPA Proposed CO_2 Target Standards and NHTSA Proposed Fuel Consumption Target Standards for Diesel HD Pickups and Vans

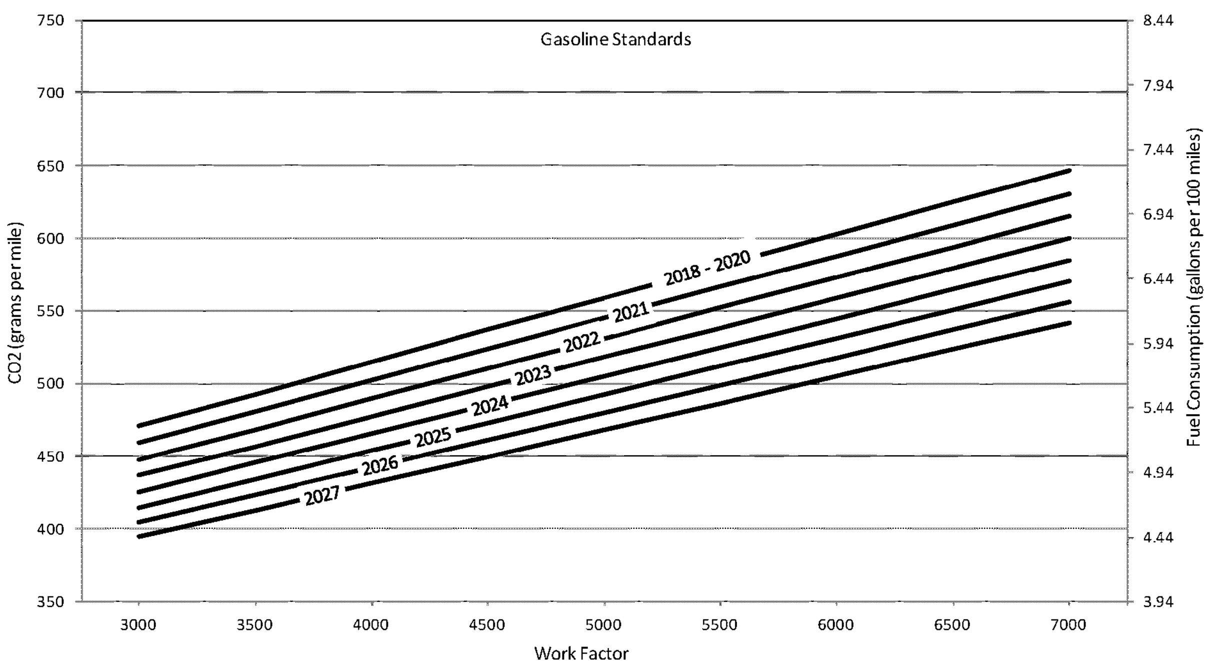

Figure VI-4 EPA Proposed CO_2 Target Standards and NHTSA Proposed Fuel Consumption Target Standards for Gasoline HD Pickups and Vans

Described mathematically, EPA's and NHTSA's proposed target standards are defined by the following formulas:

EPA CO_2 Target (g/mile) = [a × WF] + b

NHTSA Fuel Consumption Target (gallons/100 miles) = [c × WF] + d

Where:

WF = Work Factor = [0.75 × (Payload Capacity + xwd)] + [0.25 × Towing Capacity]

Payload Capacity = GVWR (lb) − Curb Weight (lb)

xwd = 500 lb if the vehicle is equipped with 4wd, otherwise equals 0 lb.

Towing Capacity = GCWR (lb) − GVWR (lb)

Coefficients a, b, c, and d are taken from Table VI–2.

TABLE VI–2—PROPOSED PHASE 2 COEFFICIENTS FOR HD PICKUP AND VAN TARGET STANDARDS

Model year	a	b	c	d
Diesel Vehicles				
2018–2020 [a]	0.0416	320	0.0004086	3.143
2021	0.0406	312	0.0003988	3.065
2022	0.0395	304	0.0003880	2.986
2023	0.0386	297	0.0003792	2.917
2024	0.0376	289	0.0003694	2.839
2025	0.0367	282	0.0003605	2.770
2026	0.0357	275	0.0003507	2.701
2027 and later	0.0348	268	0.0003418	2.633
Gasoline Vehicles				
2018–2020 [a]	0.044	339	0.0004951	3.815
2021	0.0429	331	0.0004827	3.725
2022	0.0418	322	0.0004703	3.623
2023	0.0408	314	0.0004591	3.533
2024	0.0398	306	0.0004478	3.443
2025	0.0388	299	0.0004366	3.364
2026	0.0378	291	0.0004253	3.274
2027 and later	0.0369	284	0.0004152	3.196

Note:
[a] Phase 1 primary phase-in coefficients. Alternative phase-in coefficients are different in MY2018 only.

As noted above, the standards are not proposed to change from the final Phase 1 standards for MYs 2018–2020. The MY 2018–2020 standards are shown in the Figures and tables above for reference.

NHTSA and EPA have also analyzed regulatory alternatives to the proposed standards, as discussed in Sections VI.C and D and Section X. below. The agencies request comments on all of the alternatives analyzed for the proposal, but request comments on Alternative 4 in particular. The agencies believe Alternative 4 has the potential to be the maximum feasible alternative; however, based on the evidence currently before us, EPA and NHTSA have outstanding questions regarding relative risks and benefits of Alternative 4 due to the timeframe envisioned by that alternative. Alternative 4 would provide less lead time for the complete phase-in of the proposed Phase 2 standards based on an annual improvement of 3.5 percent per year in MYs 2021–2025 compared to the proposed Alternative 3 per year improvement of 2.5 percent in MYs 2021–2027. The CO_2 and fuel consumption attribute-based target standards for the Alternative 4 phase-in are shown in Figure VI–5 and Figure VI–6 below. As the target curves for Alternative 4 show in comparison to the target curves shown above for the proposed Alternative 3, the final Phase 2 standards would result in essentially the same level of stringency under either alternative. However, the Phase 2 standards would be fully implemented two years earlier, in MY 2025, under Alternative 4. The agencies are seriously considering whether this Alternative 4 (*i.e.,* the proposed standards but with two years less lead-time) would be realistic and feasible, as described in Sections VI.C and D, Section X, and in the Draft RIA Chapter 11. Alternative 4 is predicated on shortened lead time that would result in accelerated and in some cases higher adoption rates of the same technologies on which the proposed Alternative 3 is predicated. The agencies request comments, data, and information that would help inform determination of the maximum feasible (for NHTSA) and appropriate (for EPA) stringency for HD pickups and vans and are particularly interested in information and data related to the expected adoption rates of different emerging technologies, such as mild and strong hybridization.

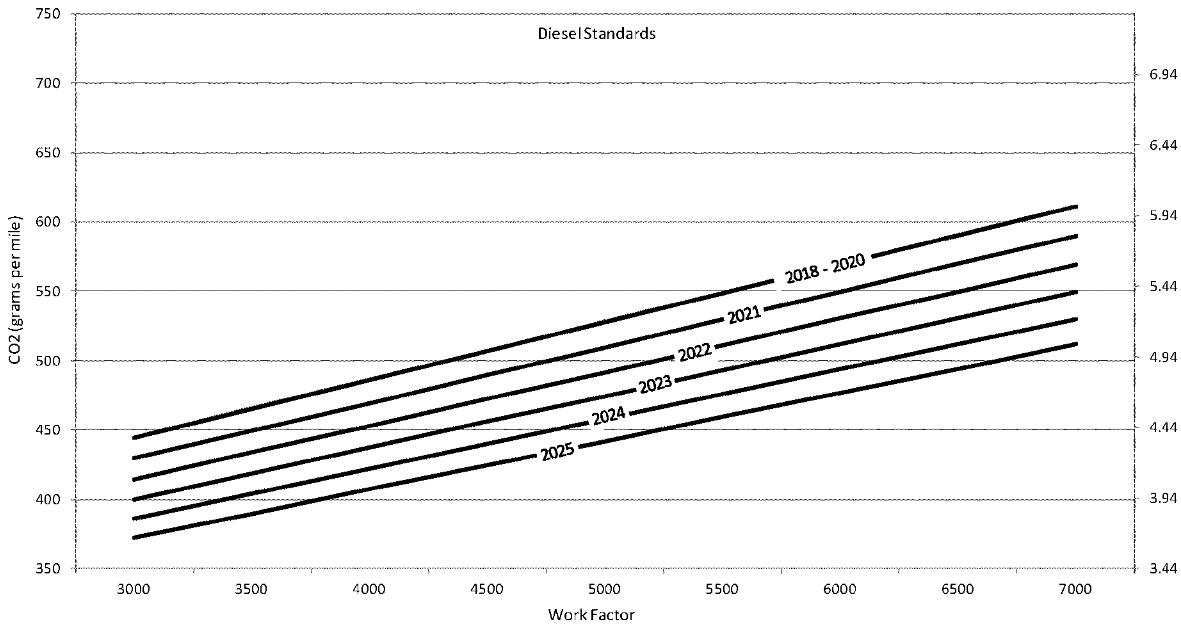

Figure VI-5 Alternative 4 EPA CO_2 Target Standards and NHTSA Fuel Consumption Target Standards for Diesel HD Pickups and Vans

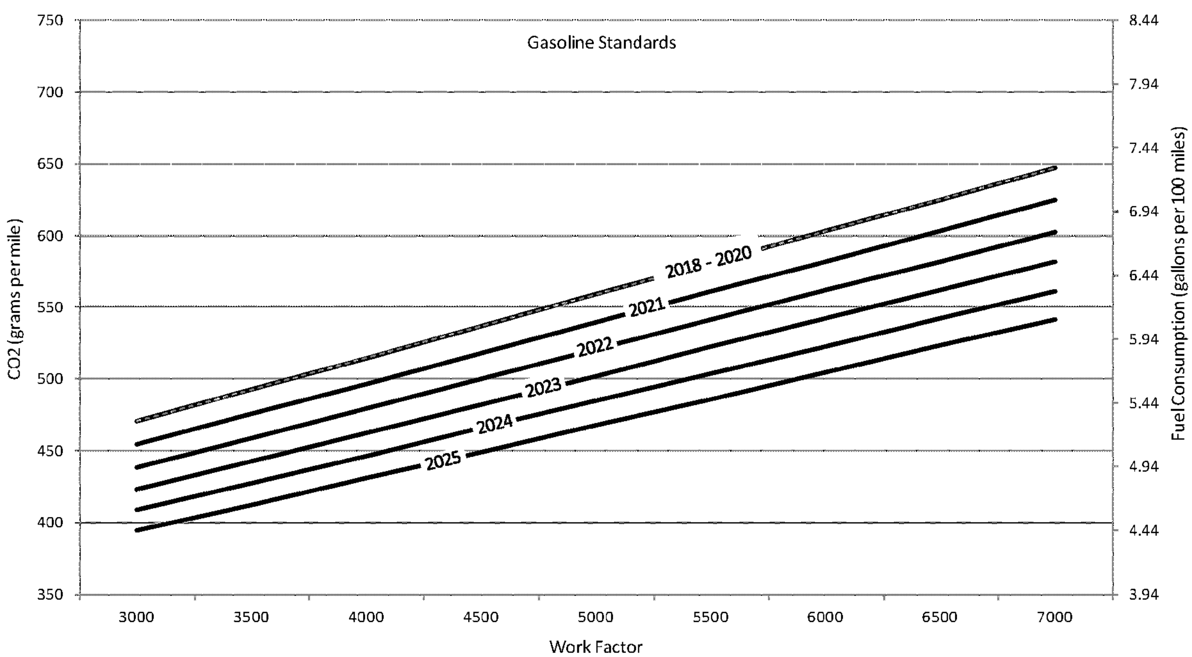

Figure VI-6 Alternative 4 EPA CO_2 Target Standards and NHTSA Fuel Consumption Target Standards for Gasoline HD Pickups and Vans

As with Phase 1 standards, to calculate a manufacturer's HD pickup and van fleet average standard, the agencies are proposing that separate target curves be used for gasoline and diesel vehicles. The agencies' proposed standards result in approximately 16 percent reductions in CO_2 and fuel consumption for both diesel and gasoline vehicles relative to the MY 2018 Phase 1 standards for HD pickup trucks and vans. These target reductions are based on the agencies' assessment of the feasibility of incorporating technologies (which differ for gasoline and diesel powertrains) in the 2021–2027 model years, and on the differences in relative efficiency in the current gasoline and diesel vehicles.

The agencies generally prefer to set standards that do not distinguish between fuel types where technological or market-based reasons do not strongly argue otherwise. However, as with Phase 1, we continue to believe that fundamental differences between spark ignition and compression ignition engines warrant unique fuel standards, which is also important in ensuring that our program maintains product choices available to vehicle buyers. In fact, gasoline and diesel fuel behave so differently in the internal combustion engine that they have historically required unique test procedures, emission control technologies and emission standards. These technological differences between gasoline and diesel engines for GHGs and fuel consumption exist presently and will continue to exist after Phase 1 and through Phase 2 until advanced research evolves the gasoline fueled engine to diesel-like efficiencies. This will require significant technological breakthroughs currently in early stages of research such as homogeneous charge compression ignition (HCCI) or similar concepts. Because these technologies are still in the early research stages, we believe the proposed separate fuel type standards are appropriate in the timeframe of this rule to protect for the availability of both gasoline and diesel engines and will result in roughly equivalent redesign burdens for engines of both fuel types as evidenced by feasibility and cost analysis in RIA Chapter 10. The agencies request comment on the level of stringency of the proposed standards, the continued separate targets for gasoline and diesel HD pickups and vans, and the continued use of the work-based attribute approach described above.

The proposed NHTSA fuel consumption target curves and EPA GHG target curves are equivalent. The agencies established the target curves using the direct relationship between fuel consumption and CO_2 using conversion factors of 8,887 g CO_2/gallon for gasoline and 10,180 g CO_2/gallon for diesel fuel.

It is expected that measured performance values for CO_2 will generally be equivalent to fuel consumption. However, Phase 1 established a provision that EPA is not proposing to change for Phase 2 that allows manufacturers, if they choose, to use CO_2 credits to help demonstrate compliance with N_2O and CH_4 emissions standards, by expressing any N_2O and CH_4 under compliance in terms of their CO_2-equivalent and applying CO_2 credits as needed. For test families that do not use this compliance alternative, the measured performance values for CO_2 and fuel consumption will be equivalent because the same test runs and measurement data will be used to determine both values, and calculated fuel consumption will be based on the same conversion factors that are used to establish the relationship between the CO_2 and fuel consumption target curves (8,887 g CO_2/gallon for gasoline and 10,180 g CO_2/gallon for diesel fuel). For manufacturers that choose to use EPA provision for CO_2 credit use in demonstrating N_2O and CH_4 compliance, compliance with the CO_2 standard will not be directly equivalent to compliance with the NHTSA fuel consumption standard.

(2) What are the HD Pickup and Van Test Cycles and Procedures?

The Phase 1 program established testing procedures for HD pickups and vans and NHTSA and EPA are not proposing to change these testing protocols. The vehicles would continue to be tested using the same heavy-duty chassis test procedures currently used by EPA for measuring criteria pollutant emissions from these vehicles, but with the addition of the highway fuel economy test cycle (HFET). These test procedures are used by manufacturers for certification and emissions compliance demonstrations and by the agencies for compliance verification and enforcement. Although the highway cycle driving pattern is identical to that of the light-duty test, other test parameters for running the HFET, such as test vehicle loaded weight, are identical to those used in running the current EPA Federal Test Procedure for complete heavy-duty vehicles. Please see Section II.C (2) of the Phase 1 preamble (76 FR 57166) for a discussion of how HD pickups and vans would be tested.

One item that the agencies are considering to change is how vehicles are categorized into test weight bins. Under the current test procedures, vehicles are tested at 500 lb increments of inertial weight classes when testing at or above 5500 lbs test weight. For example, all vehicles having a calculated test weight basis of 11,251 to 11,750 lbs would be tested 11,500 lbs (*i.e.,* the midpoint of the range). However, for some vehicles, the existence of these bins and the large intervals between bins may reduce or eliminate the incentive for mass reduction for some vehicles, as a vehicle may require significant mass reduction before it could switch from one test weight bin to the next lower bin. For other vehicles, these bins may unduly reward relatively small reductions of vehicle mass, as a vehicle's mass may be only slightly greater than that needed to be assigned a 500-pound lighter inertia weight class. For example, for a vehicle with a calculated test weight basis of 11,700 lbs, a manufacturer would receive no regulatory benefit for reducing the vehicle weight by 400 lbs, because the vehicle would stay within the same weight bracket. The agencies do recognize that the test weight bins allow for some reduction in testing burden as many vehicles can be grouped together under a single test. For Phase 2, the agencies seek comment on whether the test weight bins should be changed in order to allow for more realistic testing of HD pickups and vans and better capture of the improvements due to mass reduction. Some example changes could include reducing the five hundred pound interval between bins to smaller intervals similar to those allowed for vehicles tested below 5,500 lbs. test weight, or allowing any test weight value that is not fixed to a particular test weight bin. The latter scenario would still allow some grouping of vehicles to reduce test burden, and the agencies also seek comment on how vehicles would be grouped and how the test weight of this group of vehicles should be selected.

We further seek comment as to whether there may be a more appropriate method such as allowing analytical adjustment of the CO_2 levels and fuel consumption within a vehicle weight class to more precisely account for the individual vehicle models performance. For example, could an equation like the one specified in 40 CFR 1037.104(g) for analytically adjusting CO_2 emissions be used (note that this is proposed to be redesignated as 40 CFR 86.1819–14(g)). The agencies are specifically considering an approach in which vehicles are tested in the same way with the same test weights, but manufacturers have the option to either accept the emission results as provided under the current regulations, or choose to adjust the emissions based on the actual test weight basis (actual curb plus half payload) instead of the equivalent test weight for the 500 test weight interval. Should the agencies finalize this as an option, manufacturers choosing to adjust their emissions would be required to do so for all of their vehicles, and not just for those with test weights below the midpoint of the range.

(3) Fleet Average Standards

NHTSA and EPA are proposing to retain the fleet average standards approach finalized in the Phase 1 rule and structurally similar to light-duty Corporate Average Fuel Economy (CAFE) and GHG standards. The fleet average standard for a manufacturer is a production-weighted average of the work factor-based targets assigned to unique vehicle configurations within each model type produced by the manufacturer in a model year. Each manufacturer would continue to have an average GHG requirement and an average fuel consumption requirement unique to its new HD pickup and van fleet in each model year, depending on the characteristics (payload, towing, and drive type) of the vehicle models produced by that manufacturer, and on the U.S.-directed production volume of each of those models in that model year. Vehicle models with larger payload/towing capacities and/or four-wheel drive have individual targets at numerically higher CO_2 and fuel consumption levels than less capable vehicles, as discussed in Section VI.B(1).

The fleet average standard with which the manufacturer must comply would continue to be based on its final production figures for the model year, and thus a final assessment of compliance would occur after production for the model year ends. The assessment of compliance also must consider the manufacturer's use of carry-forward and carry-back credit provisions included in the averaging, banking, and trading program. Because compliance with the fleet average standards depends on actual test group production volumes, it is not possible to determine compliance at the time the manufacturer applies for and receives an (initial) EPA certificate of conformity for a test group. Instead, at certification the manufacturer would demonstrate a level of performance for vehicles in the test group, and make a good faith demonstration that its fleet, regrouped by unique vehicle configurations within each model type, is expected to comply with its fleet average standard when the model year is over. EPA will issue a certificate for the vehicles covered by the test group based on this demonstration, and will include a condition in the certificate that if the manufacturer does not comply with the fleet average, then production vehicles from that test group will be treated as not covered by the certificate to the extent needed to bring the manufacturer's fleet average into compliance. As in the parallel program for light-duty vehicles, additional "model type" testing will be conducted by the manufacturer over the course of the model year to supplement the initial test group data. The emissions and fuel consumption levels of the test vehicles will be used to calculate the production-weighted fleet averages for the manufacturer, after application of the appropriate deterioration factor to each result to obtain a full useful life value. Please see Section II.C (3)(a) of the Phase 1 preamble (76 FR 57167) for further discussion of the fleet average approach for HD pickups and vans.

(4) In-Use Standards

Section 202(a)(1) of the CAA specifies that EPA set emissions standards that are applicable for the useful life of the vehicle. EPA is proposing to continue the in-use standards approach for individual vehicles that EPA finalized for the Phase 1 program. NHTSA did not adopt Phase 1 in-use standards and is not proposing in-use standards for Phase 2. For the EPA program, compliance with the in-use standard for individual vehicles and vehicle models does not impact compliance with the fleet average standard, which will be based on the production-weighted average of the new vehicles. Vehicles that fail to meet their in-use emission standards would be subject to recall to correct the noncompliance. NHTSA also proposes to adopt EPA's useful life requirements to ensure manufacturers consider in the design process the need for fuel efficiency standards to apply for the same duration and mileage as EPA standards. NHTSA seeks comment on the appropriateness of seeking civil penalties for failure to comply with its fuel efficiency standards in these instances. NHTSA would limit such penalties to situations in which it determined that the vehicle or engine manufacturer failed to comply with the standards.

As with Phase 1, EPA proposes that the in-use Phase 2 standards for HD pickups and vans be established by adding an adjustment factor to the full useful life emissions used to calculate the GHG fleet average. EPA proposes that each model's in-use CO_2 standard be the model-specific level used in calculating the fleet average, plus 10 percent. No adverse comments were received on this provision during the Phase 1 rulemaking. Please see Section II.C (3)(b) of the Phase 1 preamble (76 FR 57167) for further discussion of in-use standards for HD pickups and vans.

For Phase 1, EPA aligned the useful life for GHG emissions with the useful life that was in place for criteria pollutants: 11 years or 120,000 miles, whichever occurs first (40 CFR 86.1805–04(a)). Since the Phase 1 rule was finalized, EPA updated the useful life for criteria pollutants as part of the Tier 3 rulemaking.[333] The new useful life implemented for Tier 3 is 150,000 miles or 15 years, whichever occurs first. EPA and NHTSA propose that the useful life for GHG emissions and fuel consumption also be updated to 150,000 miles/15 years starting in MY 2021 when the Phase 2 standards begin so that the useful life remains aligned for GHG and criteria pollutant standards long term. With the relatively flat deterioration generally associated with CO_2 and fuel consumption and the proposed in-use standard adjustment factor discussed above, the agencies do not believe the proposed change in useful life would significantly affect the feasibility of the proposed Phase 2 standards.[334] The agencies requests comments on the proposed change to useful life.

(5) Other GHG Standards for HD Pickups and Vans

This section addresses greenhouse gases other than CO_2. Note that since these are greenhouse gases not directly related to fuel consumption, NHTSA does not have equivalent standards.

(a) Nitrous Oxide (N_2O) and Methane (CH_4)

In the Phase 1 rule, EPA established emissions standards for HD pickups and vans for both nitrous oxide (N_2O) and methane (CH_4). Similar to the CO_2 standard approach, the N_2O and CH_4 emission levels of a vehicle are based on a composite of the light-duty FTP and HFET cycles with the same 55 percent city weighting and 45 percent highway weighting. The N_2O and CH_4 standards were both set by EPA at 0.05 g/mile. Unlike the CO_2 standards, averaging between vehicles is not allowed. The standards are designed to prevent increases in N_2O and CH_4 emissions

[333] 79 FR 23492, April 28, 2014 and 40 CFR 86.1805–17.

[334] As discussed below in Section VI.D.1., EPA and NHTSA are proposing an adjustment factor of 1.25 for banked credits that are carried over from Phase 1 to Phase 2. The useful life is factored into the credits calculation and without the adjustment factor the change in useful life would effectively result in a discount of those carry-over credits.

from current levels, *i.e.,* a no-backsliding standard. EPA is not proposing to change the N_2O or CH_4 standards or related provisions established in the Phase 1 rule. Please see Phase 1 preamble Section II.E. (76 FR 57188–57193) for additional discussion of N_2O and CH_4 emissions and standards.

Across both current gasoline- and diesel-fueled heavy-duty vehicle designs, emissions of CH_4 and N_2O are relatively low and the intent of the cap standards is to ensure that future vehicle technologies or fuels do not result in an increase in these emissions. Given the global warning potential (GWP) of CH_4, the 0.05 g/mile cap standard is equivalent to about 1.25 g/mile CO_2, which is much less than 1 percent of the overall GHG emissions of most HD pickups and vans.[335] The effectiveness of oxidation of CH_4 using a three-way or diesel oxidation catalyst is limited by the activation energy, which tends to be higher where the number of carbon atoms in the hydrocarbon molecule is low and thus CH_4 is very stable. At this time we are not aware of any technologies beyond the already present catalyst systems which are highly effective at oxidizing most hydrocarbon species for gasoline and diesel fueled engines that would further lower the activation energy across the catalyst or increase the energy content of the exhaust (without further increasing fuel consumption and CO_2 emissions) to further reduce CH_4 emissions at the tailpipe. We note that we are not aware of any new technologies that would allow us to adopt more stringent CH_4 and N_2O standards at this time. The CH_4 standard remains an important backstop to prevent future increases in CH_4 emissions.

N_2O is emitted from gasoline and diesel vehicles mainly during specific catalyst temperature conditions conducive to N_2O formation. The 0.05 g/mile standard, which translates to a CO_2-equivalent value of 14.9 g/mile, ensures that systems are not designed in a way that emphasizes efficient NO_X control while allowing the formation of significant quantities of N_2O. The Phase 1 N_2O standard of 0.05 g/mile for pickups and vans was finalized knowing that it is more stringent than the Phase 1 N_2O engine standard of 0.10 g/hp-hr, currently being revaluated as discussed in Section II.D.3. EPA continues to believe that the 0.05 g/mile standard provides the necessary assurance that N_2O will not significantly increase, given the mix of gasoline and diesel fueled engines in this market and the upcoming implementation of the light-duty and heavy-duty (up to 14,000 lbs. GVWR) Tier 3 NO_X standards. EPA knows of no technologies that would lower N_2O emissions beyond the control provided by the precise emissions control systems already being implemented to meet EPA's criteria pollutant standards. Therefore, EPA continues to believe the 0.05 g/mile N_2O standard remains appropriate.

If a manufacturer is unable to meet the N_2O or CH_4 cap standards, the EPA program allows the manufacturer to comply using CO_2 credits. In other words, a manufacturer may offset any N_2O or CH_4 emissions above the standard by taking steps to further reduce CO_2. A manufacturer choosing this option would use GWPs to convert its measured N_2O and CH_4 test results that are in excess of the applicable standards into CO_2eq to determine the amount of CO_2 credits required. For example, a manufacturer would use 25 Mg of positive CO_2 credits to offset 1 Mg of negative CH_4 credits or use 298 Mg of positive CO_2 credits to offset 1 Mg of negative N_2O credits.[336] By using the GWP of N_2O and CH_4, the approach recognizes the inter-correlation of these compounds in impacting global warming and is environmentally neutral for demonstrating compliance with the individual emissions caps. Because fuel conversion manufacturers certifying under 40 CFR part 85, subpart F, do not participate in ABT programs, EPA included in the Phase 1 rule a compliance option for fuel conversion manufacturers to comply with the N_2O and CH_4 standards that is similar to the credit program described above. See 76 FR 57192. The compliance option will allow conversion manufacturers, on an individual engine family basis, to convert CO_2 over compliance into CO_2 equivalents (CO_2 eq) of N_2O and/or CH_4 that can be subtracted from the CH_4 and N_2O measured values to demonstrate compliance with CH_4 and/or N_2O standards. EPA did not include similar provisions allowing over compliance with the N_2O or CH_4 standards to serve as a means to generate CO_2 credits because the CH_4 and N_2O standards are cap standards representing levels that all but the worst vehicles should already be well below. Allowing credit generation against such cap standard would provide a windfall credit without any true GHG reduction. EPA proposes to maintain these provisions for Phase 2 as they provide important flexibility without reducing the overall GHG benefits of the program.

EPA is requesting comment on updating GWPs used in the calculation of credits discussed above. Please see the full discussion of this issue and request for comments provided in Sections II.D and XI.D.

(b) Air Conditioning Related Emissions

Air conditioning systems contribute to GHG emissions in two ways—direct emissions through refrigerant leakage and indirect exhaust emissions due to the extra load on the vehicle's engine to provide power to the air conditioning system. HFC refrigerants, which are powerful GHG pollutants, can leak from the A/C system. This includes the direct leakage of refrigerant as well as the subsequent leakage associated with maintenance and servicing, and with disposal at the end of the vehicle's life.[337] Currently, the most commonly used refrigerant in automotive applications—R134a, has a high GWP. Due to the high GWP of R134a, a small leakage of the refrigerant has a much greater global warming impact than a similar amount of emissions of CO_2 or other mobile source GHGs.

In Phase 1, EPA finalized low leakage requirement for all air conditioning systems installed in 2014 model year and later HDVs, with the exception of Class 2b–8 vocational vehicles. As discussed in Section V.B.3, EPA is proposing to extend leakage standards to vocational vehicles for Phase 2. For air conditioning systems with a refrigerant capacity greater than 733 grams, EPA finalized a leakage standard which is a ''percent refrigerant leakage per year'' to assure that high-quality, low-leakage components are used in each air conditioning system design. EPA finalized a standard of 1.50 percent leakage per year for heavy-duty pickup trucks and vans and Class 7 and 8 tractors. See Section II.E.5. of Phase 1 preamble (76 FR 57194–57195) for further discussion of the A/C leakage standard.

In addition to use of leak-tight components in air conditioning system design, manufacturers could also decrease the global warming impact of leakage emissions by adopting systems that use alternative, lower global warming potential (GWP) refrigerants, to replace the refrigerant most commonly used today, HFC–134a (R–134a). The potential use of alternative refrigerants in HD vehicles and EPA's proposed revisions to 40 CFR 1037.115 so that use

[335] N_2O has a GWP of 298 and CH_4 has a GWP of 25 according to the IPCC AR4.

[336] N_2O has a GWP of 298 and CH_4 has a GWP of 25 according to the IPCC AR4.

[337] The U.S. EPA has reclamation requirements for refrigerants in place under Title VI of the Clean Air Act.

of certain lower GWP refrigerants would cause an air conditioning system in a HD vehicle to be deemed to comply with the low leakage standard is discussed in Section I.F. above.

In addition to direct emissions from refrigerant leakage, air conditioning systems also create indirect exhaust emissions due to the extra load on the vehicle's engine to provide power to the air conditioning system. These indirect emissions are in the form of the additional CO_2 emitted from the engine when A/C is being used due to the added loads. Unlike direct emissions which tend to be a set annual leak rate not directly tied to usage, indirect emissions are fully a function of A/C usage. These indirect CO_2 emissions are associated with air conditioner efficiency, since (as just noted) air conditioners create load on the engine. *See* 74 FR 49529. In Phase 1, the agencies did not set air conditioning efficiency standards for vocational vehicles, combination tractors, or heavy-duty pickup trucks and vans. The CO_2 emissions due to air conditioning systems in these heavy-duty vehicles were estimated to be minimal compared to their overall emissions of CO_2. This continues to be the case. For this reason, EPA is not proposing to establish standards for A/C efficiency for Phase 2.

NHTSA and EPA request comments on all aspects of the proposed HD pickup and van standards and program elements described in this section.

C. Feasibility of Pickup and Van Standards

EPCA and EISA require NHTSA to ''implement a commercial medium- and heavy-duty on-highway vehicle and work truck fuel efficiency improvement program designed to achieve the maximum feasible improvement'' and to establish corresponding fuel consumption standards ''that are appropriate, cost-effective, and technologically feasible.'' [338] Section 202(a)(1) and (2) of the Clean Air Act require EPA to establish standards for emissions of pollutants from new motor vehicles and engines which emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, which include GHGs. See section I.E. above. Under section 202(a)(1) and (2), EPA considers such issues as technology effectiveness, its cost (both per vehicle, per manufacturer, and per consumer), the lead time necessary to implement the technology, and based on this the feasibility and practicability of potential standards; the impacts of potential standards on emissions reductions of both GHGs and non-GHG emissions; the impacts of standards on oil conservation and energy security; the impacts of standards on fuel savings by customers; the impacts of standards on the truck industry; other energy impacts; as well as other relevant factors such as impacts on safety.

As part of the feasibility analysis of potential standards for HD pickups and vans, the agencies have applied DOT's CAFE Compliance and Effects Modeling System (sometimes referred to as ''the CAFE model'' or ''the Volpe model''), which DOT's Volpe National Transportation Systems Center (Volpe Center) developed, maintains, and applies to support NHTSA CAFE analyses and rulemakings.[339] The agencies used this model to determine the range of stringencies that might be achievable through the use of technology that is projected to be available in the Phase 2 time frame. From these runs, the agencies identified the stringency level that would be technology-forcing (*i.e.* reflect levels of stringency based on performance of merging as well as currently available control technologies), but leave manufacturers the flexibility to adopt varying technology paths for compliance and allow adequate lead time to develop, test, and deploy the range of technologies.

As noted in Section I and discussed further below, the analysis considers two reference cases for HD pickups and vans, a flat baseline (designated Alternative 1a) where no improvements are modeled beyond those needed to meet Phase 1 standards and a dynamic baseline (designated Alternative 1b) where certain cost-effective technologies (*i.e.,* those that payback within a 6 month period) are assumed to be applied by manufacturers to improve fuel efficiency beyond the Phase 1 requirements in the absence of new Phase 2 standards. NHTSA considered its primary analysis to be based on the more dynamic baseline whereas EPA considered both reference cases. As shown below and in Sections VII through X, using the two different reference cases has little impact on the results of the analysis and would not lead to a different conclusion regarding the appropriateness of the proposed standards. As such, the use of different reference cases corroborates the results of the overall analysis.

The proposed phase-in schedule of reduction of 2.5 percent per year in fuel consumption and CO_2 levels relative to the 2018 MY Phase 1 standard level, starting in MY 2021 and extending through MY 2027, was chosen to strike a balance between meaningful reductions in the early years and providing manufacturers with needed lead time via a gradually accelerating ramp-up of technology penetration. By expressing the phase-in in terms of increasing year to year stringency for each manufacturer, while also providing for credit generation and use (including averaging, carry-forward, and carry-back), we believe our proposed program would afford manufacturers substantial flexibility to satisfy the proposed phase-in through a variety of pathways: the gradual application of technologies across the fleet, greater application levels on only a portion of the fleet, and a sufficiently broad set of available technologies to account for the variety of current technology deployment among manufacturers and the lowest-cost compliance paths available to each.

We decided to propose a phased implementation schedule that would be appropriate to accommodate manufacturers' redesign workload and product schedules, especially in light of this sector's limited product offerings [340] and long product cycles. We did not estimate the cost of implementing the proposed standards immediately in 2021 without a phase-in, but we qualitatively assessed it to be somewhat higher than the cost of the phase-in we are proposing, due to the workload and product cycle disruptions it could cause, and also due to manufacturers' resulting need to develop some of these technologies for heavy-duty applications sooner than or simultaneously with light-duty development efforts. See 75 FR 25451 (May 7, 2010) (documenting types of drastic cost increases associated with trying to accelerate redesign schedules and concluding that ''[w]e believe that it would be an inefficient use of societal resources to incur such costs when they can be obtained much more cost effectively just one year later''). On the other hand, waiting until 2027 before applying any new standards could miss

[338] 49 U.S.C. 32902(k)(2).

[339] The CAFE model has been under ongoing development, application, review, and refinement since 2002. In five rulemakings subject to public review and comment, DOT has used the model to estimate the potential impacts of new CAFE standards. The model has also been subject to formal review outside the rulemaking process, and DOT anticipates comments on the model in mid-2015 as part of a broader report under development by the National Academy of Sciences (NAS). The model, underlying source code, inputs, and outputs are available at NHTSA's Web site, and some outside organizations are making use of the model. The agency anticipates that stakeholders will have comments on recent model changes made to accommodate standards for HD pickups and vans.

[340] Manufacturers generally have only one pickup platform and one van platform in this segment.

the opportunity to achieve meaningful and cost-effective early reductions not requiring a major product redesign.

The agencies believe that Alternative 4 has the potential to be the maximum feasible alternative, however, the agencies are uncertain that the potential technologies and market penetration rates included in Alternative 4 are currently technologically feasible. Alternative 4 would ultimately reach the same levels of stringency as Alternative 3, but would do so with less lead time. This could require the application of a somewhat different (and possibly broader) application of the projected technologies depending on product redesign cycles. We expect, in fact, that some of these technologies may well prove feasible and cost-effective in this timeframe, and may even become technologies of choice for individual manufacturers.

Additionally, Alternative 3 provides two more years of phase-in than Alternative 4, which eases compliance burden by having more vehicle redesigns and lower stringency during the phase-in period. Historically, the vehicles in this segment are typically only redesigned every 6–10 years, so many of the vehicles may not even be redesigned during the timeframe of the stringency increase. In this case, a manufacturer must either make up for any vehicle that falls short of its target through some combination of early compliance, overcompliance, credit carry-forward and carry-back, and redesigning vehicles more frequently. Each of these will increase technology costs to the manufacturers and vehicle purchasers, and early redesigns will significantly increases capital costs and product development costs. Also, the longer phase-in time for Alternative 3 means that any manufacturer will have a slightly lower target to meet from 2021–2026 than for the shorter phase-in of Alternative 4, though by 2027 the manufacturers will have the same target in either alternative.

Alternative 4 is projected to be met using a significantly higher degree of hybridization including the use of more strong hybrids, compared to the proposed preferred Alternative 3. In order to comply with a 3.5 percent per year increase in stringency over MYs 2021–2025, manufacturers would need to adopt more technology compared to the 2.5 percent per year increase in stringency over MYs 2021–2027. The two years of additional lead time provided by Alternative 3 to achieve the proposed final standards reduces the potential number of strong hybrids projected to be used by allowing for other more cost effective technologies to be more fully utilized across the fleet. Alternative 4 is also projected to result in higher costs and risks than the proposed Alternative 3 due to the projected higher technology adoption rates with the additional emission reductions and fuel savings predominately occurring only during the program phase-in period. The agencies' analysis is discussed in detail below.

In some cases, the model selects strong hybrids as a more cost effective technology over certain other technologies including stop-start and mild hybrid. In other words, strong hybrids are not a technology of last resort in the analysis. The agencies believe it is technologically feasible to apply hybridization to HD pickups and vans in the lead time provided. However, strong hybrids present challenges in this market segment compared to light-duty where there are several strong hybrids already available. The agencies do not believe that at this stage there is enough information about the viability of strong hybrid technology in this vehicle segment to assume that they can be a part of large-volume deployment strategies for regulated manufacturers. For example, we believe that hybrid electric technology could provide significant GHG and fuel consumption benefits, but we recognize that there is uncertainty at this time over the real world effectiveness of these systems in HD pickups and vans, and over customer acceptance of the technology for vehicles with high GCWR towing large loads. Further, the development, design, and tooling effort needed to apply this technology to a vehicle model is quite large, and might not be cost-effective due to the small sales volumes relative to the light-duty sector. Additionally, the analysis does not project that engines would be down-sized in conjunction with hybridization for HD pickups and vans due to the importance pickup trucks buyers place on engine horsepower and torque necessary to meet towing objectives. Therefore, with no change projected for engine size, the strong hybrid costs do not include costs for engine changes. In light-duty, the use of smaller engines facilitates much of a hybrid's benefit.

Due to these considerations, the agencies have conducted a sensitivity analysis that is based on the use of no strong hybrids. The results of the analysis are also discussed below. The analysis indicates that there would be a technology pathway that would allow manufacturers to meet both the proposed preferred Alternatives 3 and Alternative 4 without the use of strong hybrids. However, the analysis indicates that costs would be higher and the cost effectiveness would be lower under the no strong hybrid approach, especially for Alternative 4, which provides less lead time to manufacturers.

We also considered proposing less stringent standards under which manufacturers could comply by deploying a more limited set of technologies. However, our assessment concluded with a high degree of confidence that the technologies on which the proposed standards are premised would be available at reasonable cost in the 2021–2027 timeframe, and that the phase-in and other flexibility provisions allow for their application in a very cost-effective manner, as discussed in this section below.

More difficult to characterize is the degree to which more or less stringent standards might be appropriate because of under- or over-estimating the costs or effectiveness of the technologies whose performance is the basis of the proposed standards. For the most part, these technologies have not yet been applied to HD pickups and vans, even on a limited basis. We are therefore relying to some degree on engineering judgment in predicting their effectiveness. Even so, we believe that we have applied this judgment using the best information available, primarily from a NHTSA contracted study at SwRI[341] and our recent rulemaking on light-duty vehicle GHGs and fuel economy, and have generated a robust set of effectiveness values. Chapter 10 of the draft RIA provides a detailed description of the CAFE Model and the analysis performed for the proposal.

(1) Regulatory Alternatives Considered by the Agencies

As discussed above, the agencies are proposing standards defined by fuel consumption and GHG targets that continue through model year 2020 unchanged from model year 2018, and then increase in stringency at an annual rate of 2.5 percent through model year 2027. In addition to this regulatory alternative, the agencies also considered a no-action alternative under which standards remain unchanged after model year 2018, as well as three other alternatives, defined by annual stringency increases of 2.0 percent, 3.5 percent, and 4.0 percent during 2021–2025. For each of the ''action alternatives'' (*i.e.,* those involving stringency increases beyond the no-

[341] Reinhart, T.E. (June 2015). *Commercial Medium- and Heavy-Duty Truck Fuel Efficiency Technology Study—Report #1.* (Report No. DOT HS 812 146). Washington, DC: National Highway Traffic Safety Administration.

action alternative), the annual stringency increases are applied as follows: An annual stringency increase of *r* is applied by multiplying the model year 2020 target functions (identical to those applicable to model year 2018) by $1-r$ to define the model year 2021 target functions, multiplying the model year 2021 target functions by $1-r$ to define the model year 2022 target functions, continuing through 2025 for all alternatives except for the preferred Alternative 3 which extends through 2027. In summary, the agencies have considered the following five regulatory alternatives in Table VI–3.

TABLE VI–3 REGULATORY ALTERNATIVES

Regulatory alternative	Annual stringency increase		
	2019–2020	2021–2025	2026–2027
1: No Action	None	None	None
2: 2.0%/y	None	2.0%	None
3: 2.5%/y	None	2.5%	2.5%
4: 3.5%/y	None	3.5%	None
5: 4.0%/y	None	4.0%	None

(2) DOT CAFE Model

DOT developed the CAFE model in 2002 to support the 2003 issuance of CAFE standards for MYs 2005–2007 light trucks. DOT has since significantly expanded and refined the model, and has applied the model to support every ensuing CAFE rulemaking for both light-duty and heavy-duty. For this analysis, the model was reconfigured to use the work based attribute metric of ''work factor'' established in the Phase 1 rule instead of the light duty ''footprint'' attribute metric.

Although the CAFE model can also be used for more aggregated analysis (*e.g.,* involving ''representative vehicles'', single-year snapshots, etc.), NHTSA designed the model with a view toward (a) detailed simulation of manufacturers' potential actions given a defined set of standards, followed by (b) calculation of resultant impacts and economic costs and benefits. The model is intended to describe actions manufacturers *could* take in light of defined standards and other input assumptions and estimates, not to predict actions manufacturers *will* take in light of competing product and market interests (*e.g.* engine power, customer features, technology acceptance, etc.).

For these rules, the agencies conducted coordinated and complementary analyses using two analytical methods for the heavy-duty pickup and van segment by employing both DOT's CAFE model and EPA's MOVES model. The agencies used EPA's MOVES model to estimate fuel consumption and emissions impacts for tractor-trailers (including the engine that powers the tractor), and vocational vehicles (including the engine that powers the vehicle). Additional calculations were performed to determine corresponding monetized program costs and benefits. For heavy-duty pickups and vans, the agencies performed complementary analyses, which we refer to as ''Method A'' and ''Method B''. In Method A, the CAFE model was used to project a pathway the industry could use to comply with each regulatory alternative and the estimated effects on fuel consumption, emissions, benefits and costs. In Method B, the CAFE model was used to project a pathway the industry could use to comply with each regulatory alternative, along with resultant impacts on per vehicle costs, and the MOVES model was used to calculate corresponding changes in total fuel consumption and annual emissions. Additional calculations were performed to determine corresponding monetized program costs and benefits. NHTSA considered Method A as its central analysis and Method B as a supplemental analysis. EPA considered the results of both methods. The agencies concluded that both methods led the agencies to the same conclusions and the same selection of the proposed standards. See Section VII for additional discussion of these two methods.

As a starting point, the model makes use of an input file defining the analysis fleet—that is, a set of specific vehicle models (*e.g.,* Ford F250) and model configurations (*e.g.,* Ford F250 with 6.2-liter V8 engine, 4WD, and 6-speed manual transmission) estimated or assumed to be produced by each manufacturer in each model year to be included in the analysis. The analysis fleet includes key engineering attributes (*e.g.,* curb weight, payload and towing capacities, dimensions, presence of various fuel-saving technologies) of each vehicle model, engine, and transmissions, along with estimates or assumptions of future production volumes. It also specifies the extent to which specific vehicle models share engines, transmissions, and vehicle platforms, and describes each manufacturer's estimated or assumed product cadence (*i.e.,* timing for freshening and redesigning different vehicles and platforms). This input file also specifies a payback period used to estimate the potential that each manufacturer might apply technology to improve fuel economy beyond levels required by standards. The file used for this analysis was created from 2014 manufacturer compliance reports for the base sales and technology information, and a future fleet projection created from a combination of data from a sales forecast that the agencies purchased from IHS Automotive and total volumes class 2b and 3 fleet volumes from 2014 AEO Reference Case. A complete description of the future fleet is available in Draft RIA Chapter 10.

A second input file to the model contains a variety of contextual estimates and assumptions. Some of these inputs, such as future fuel prices and vehicle survival and mileage accumulation (versus vehicle age), are relevant to estimating manufacturers' potential application of fuel-saving technologies. Some others, such as fuel density and carbon content, vehicular and upstream emission factors, the social cost of carbon dioxide emissions, and the discount rate, are relevant to calculating physical and economic impacts of manufacturers' application of fuel-saving technologies.

A third input file contains estimates and assumptions regarding the future applicability, availability, efficacy, and cost of various fuel-saving technologies. Efficacy is expressed in terms of the percentage reduction in fuel consumption, cost is expressed in dollars, and both efficacy and cost are expressed on an incremental basis (*i.e.,* estimates for more advanced technologies are specified as increments beyond less advanced technologies). The input file also includes ''synergy factors'' used to make adjustments accounting for the potential that some combinations of technologies may result fuel savings or costs different from those indicated by incremental values.

Finally, a fourth model input file specifies standards to be evaluated. Standards are defined on a year-by-year basis separately for each regulatory class (passenger cars, light trucks, and heavy-duty pickups and vans). Regulatory alternatives are specified as discrete scenarios, with one scenario defining the no-action alternative or ''baseline'', all other scenarios defining regulatory alternatives to be evaluated relative to that no-action alternative.

Given these inputs, the model estimates each manufacturer's potential year-by-year application of fuel-saving technologies to each engine, transmission, and vehicle. Subject to a range of engineering and planning-related constraints (*e.g.,* secondary axle disconnect can't be applied to 2-wheel drive vehicles, many major technologies can only be applied practicably as part of a vehicle redesign, and applied technologies carry forward between model years), the model attempts to apply technology to each manufacturer's fleet in a manner that minimizes ''effective costs'' (accounting, in particular, for technology costs and avoided fuel outlays), continuing to add improvements as long as doing so would help toward compliance with specified standards or would produce fuel savings that ''pay back'' at least as quickly as specified in the input file mentioned above.

After estimating the extent to which each manufacturer might add fuel-saving technologies under each specified regulatory alternative, the model calculates a range of physical impacts, such as changes in highway travel (*i.e.,* VMT), changes in fleetwide fuel consumption, changes in highway fatalities, and changes in vehicular and upstream greenhouse gas and criteria pollutant emissions. The model also applies a variety of input estimates and assumptions to calculate economic costs and benefits to vehicle owners and society, based on these physical impacts.

Since the manufacturers of HD pickups and vans generally only have one basic pickup truck and van with different versions ((*i.e.,* different wheelbases, cab sizes, two-wheel drive, four-wheel drive, etc.) there exists less flexibility than in the light-duty fleet to coordinate model improvements over several years. As such, the CAFE model allows changes to the HD pickups and vans to meet new standards according to predefined redesign cycles included as a model input. As noted above, the opportunities for large-scale changes (*e.g.,* new engines, transmission, vehicle body and mass) thus occur less frequently than in the light-duty fleet, typically at spans of eight or more years for this analysis. However, opportunities for gradual improvements not necessarily linked to large scale changes can occur between the redesign cycles (*i.e.,* model refresh). Examples of such improvements are upgrades to an existing vehicle model's engine, transmission and aftertreatment systems. Given the long redesign cycle used in this analysis and the understanding with respect to where the different manufacturers are in that cycle, the agencies have initially determined that the full implementation of the proposed standards would be feasible and appropriate by the 2027 model year.

This analysis reflects several changes made to the model since 2012, when NHTSA used the model to estimate the effects, costs, and benefits of final CAFE standards for light-duty vehicles produced during MYs 2017–2021, and augural standards for MYs 2022–2025. Some of these changes specifically enable analysis of potential fuel consumption standards (and, hence, CO_2 emissions standards harmonized with fuel consumption standards) for heavy-duty pickups and vans; other changes implement more general improvements to the model. Key changes include the following:

- Changes to accommodate standards for heavy-duty pickups and vans, including attribute-based standards involving targets that vary with ''work factor''.
- Explicit calculation of test weight, taking into account test weight ''bins'' and differences in the definition of test weight for light-duty vehicles (curb weight plus 300 pound) and heavy-duty pickups and vans (average of GVWR and curb weight).
- Procedures to estimate increases in payload when curb weight is reduced, increases in towing capacity if GVWR is reduced, and calculation procedures to correspondingly update calculated work factors.
- Inclusion of technologies not included in prior analyses.
- Changes to enable more explicit accounting for shared vehicle platforms and adoption and ''inheritance'' of major engine changes.
- Expansion of the Monte Carlo simulation procedures used to perform probabilistic uncertainty analysis.

In addition to the inputs summarized above, the agencies' analysis of potential standards for HD pickups and vans makes use of a range of other estimates and assumptions specified as inputs to the CAFE modeling system. Some significant inputs (*e.g.,* estimates of future fuel prices) also applicable to other HD segments are discussed below in Section IX. Others more specific to the analysis of HD pickups and vans are listed as follows, with additional details in section D:

- Vehicle survival and mileage accumulation
- VMT rebound
- On-road ''gap'' in fuel consumption
- Fleet population profile
- Past fuel consumption levels
- Long-term fuel consumption levels
- Payback period
- Coefficients for fatality calculations
- Compliance credits carried-forward
- Emission factors for non-CO_2 emissions
- Refueling time benefits
- External Costs of travel
- Ownership and operating costs

The CAFE model and its modifications for this rulemaking are described in more detail in Section VI. below as well as the Draft RIA Chapter 10.

(3) How Did the Agencies Develop the Analysis Fleet

In order to more accurately estimate the impacts of potential standards, the agencies are estimating the composition of the future vehicle fleet. Projections of the future vehicle fleet are also done for both vocational vehicles and tractors. The procedure for pickups and vans is more detailed, though, in order to show the differences for each manufacturer in the segment. Doing so enables estimation of the extent to which each manufacturer may need to add technology in response to a given series of attribute-based standards, accounting for the mix and fuel consumption of vehicles in each manufacturer's regulated fleet. The agencies create an analysis fleet in order to track the volumes and types of fuel economy-improving and CO_2-reducing technologies that are already present in the existing fleet of Class 2b and 3 vehicles. This aspect of the analysis fleet helps to keep the CAFE model from adding technologies to vehicles that already have these technologies, which would result in ''double counting'' of technologies' costs and benefits. An additional step involved projecting the fleet sales into MYs 2019–2030. This represents the fleet volumes that the agencies believe would exist in MYs 2019–2030. The CAFE model considers the actual redesign years of each vehicle platform for each manufacturer. Due to credit banking, some manufacturers may not need to add technology to comply with the standards until later model years, which may be after the rulemaking period. Therefore, it is necessary to run the model until all of the vehicle technology changes have stabilized.

Most of the information about the vehicles that make up the 2014 analysis fleet was gathered from the 2014 Pre-Model Year Reports submitted to EPA by the manufacturers under Phase 1 of Fuel Efficiency and GHG Emission Program for Medium- and Heavy-Duty Trucks, MYs 2014–2018. The major manufacturers of class 2b and class 3 trucks (Chrysler, Ford and GM) were asked to voluntarily submit updates to their Pre-Model Year Reports. Updated data were provided by Chrysler and GM. The agencies used these updated data in constructing the analysis fleet for these manufacturers. The agencies agreed to treat this information as Confidential Business Information (CBI) until the publication of the proposed rule. This information can be made public at this time because by now all MY2014 vehicle models have been produced, which makes data about them essentially public information.

In addition to information about each vehicle, the agencies need additional information about the fuel economy-improving/CO_2-reducing technologies already on those vehicles in order to assess how much and which technologies to apply to determine a path toward future compliance. To correctly account for the cost and effectiveness of adding technologies, it is necessary to know the technology penetration in the existing vehicle fleet. Otherwise, ''double-counting'' of technology could occur. Thus, the agencies augmented this information with publicly-available data that include more complete technology descriptions, *e.g.* for specific engines and transmissions.

The analysis fleet also requires projections of sales volumes for the years of the rulemaking analysis. The agencies relied on the MY 2014 pre-model-year compliance submissions from manufacturers to provide sales volumes at the model level based on the level of disaggregation in which the models appear in the compliance data. However, the agencies only use these reported volumes without adjustment for MY 2014. For all future model years, we combine the manufacturer submissions with sales projections from the 2014 Annual Energy Outlook Reference Case and IHS Automotive to determine model variant level sales volumes in future years.

For more detail on how the analysis fleet and sales volume projections were developed, please see Section D below as well as the draft RIA Chapter 10.

(4) What Technologies Did the Agencies Consider

The agencies considered over 35 vehicle technologies that manufacturers could use to improve the fuel consumption and reduce CO_2 emissions of their vehicles during MYs 2021–2027. The majority of the technologies described in this section are readily available, well known and proven in other vehicle sectors, and could be incorporated into vehicles once production decisions are made. Other technologies considered may not currently be in production, but are beyond the research phase and under development, and are expected to be in production in highway vehicles over the next few years. These are technologies that are capable of achieving significant improvements in fuel economy and reductions in CO_2 emissions, at reasonable costs. The agencies did not consider technologies in the research stage because there is insufficient time for such technologies to move from research to production during the model years covered by this proposed action. However, we are considering and seek comment on advanced technology credits to encourage the development of such technologies, as discussed below in Section VI.E.

The technologies considered in the agencies' analysis are briefly described below. They fall into five broad categories: Engine technologies, transmission technologies, vehicle technologies, electrification/accessory technologies, and hybrid technologies.

In this class of trucks and vans, diesel engines are installed in about half of all vehicles. The buyer's decision to purchase a diesel versus gasoline engine depends on several factors including initial purchase price, fuel operating costs, durability, towing capability and payload capacity amongst other reasons. As discussed in IV.B. above, the agencies generally prefer to set standards that do not distinguish between fuel types where technological or market-based reasons do not strongly argue otherwise. However, as with Phase 1, we continue to believe that fundamental differences between spark ignition and compression ignition engines warrant unique fuel standards, which is also important in ensuring that our program maintains product choices available to vehicle buyers. Therefore, we are proposing separate standards for gasoline and diesel vehicles and in the context of our technology discussion for heavy-duty pickups and vans, we are treating gasoline and diesel engines separately so each has a set of baseline technologies. We discuss performance improvements in terms of changes to those baseline engines. Our cost and inventory estimates contained elsewhere reflect the current fleet baseline with an appropriate mix of gasoline and diesel engines. Note that we are not basing the proposed standards on a targeted switch in the mix of diesel and gasoline vehicles. We believe our proposed standards require similar levels of technology development and cost for both diesel and gasoline vehicles. Hence the proposed program is not intended to force, nor discourage, changes in a manufacturer's fleet mix between gasoline and diesel vehicles. Types of engine technologies that improve fuel efficiency and reduce CO_2 emissions include the following:

- *Low-friction lubricants*—Low viscosity and advanced low friction lubricant oils are now available with improved performance and better lubrication. If manufacturers choose to make use of these lubricants, they would need to make engine changes and possibly conduct durability testing to accommodate the low-friction lubricants.
- *Reduction of engine friction losses*—Can be achieved through low-tension piston rings, roller cam followers, improved material coatings, more optimal thermal management, piston surface treatments, and other improvements in the design of engine components and subsystems that improve engine operation.
- *Reduction of engine parasitic demand*—Mechanical engine load reduction can be achieved by variable-displacement oil pumps, higher-efficiency direct injection fuel pumps, and variable speed/displacement coolant pumps.
- *Cylinder deactivation*—Deactivates the intake and exhaust valves and prevents fuel injection into some cylinders during light-load operation. The engine runs temporarily as though it were a smaller engine which substantially reduces pumping losses.
- *Variable valve timing*—Alters the timing of the intake valve, exhaust valve, or both, primarily to reduce pumping losses, increase specific power, and control residual gases.
- *Variable valve lift*—Alters the intake valve lift in order to reduce pumping losses and more efficiently ingest air.
- *Stoichiometric gasoline direct-injection technology*—Injects fuel at high pressure directly into the combustion chamber to improve cooling of the air/fuel charge within the cylinder, which allows for higher compression ratios and increased thermodynamic efficiency.
- *Cooled exhaust gas recirculation*—Technology that conceptually involves utilizing EGR as a charge diluent for controlling combustion temperatures and cooling the EGR prior to its introduction to the combustion system.
- *Turbocharging and downsizing*—Technology approach that conceptually involves decreasing the displacement and cylinder count to improve efficiency when not demanding regular high loads and adding a turbocharger to recover any loss to the original larger engine peak operating power. This technology was limited in this analysis to vehicles that are not expected to operate at high trailer towing levels and instead are more akin to duty cycles of light duty (*i.e.* V6 vans).
- *Lean-burn combustion*—Concept that gasoline engines that are normally stoichiometric mainly for emission reasons can run lean over a range of

operating conditions and utilize diesel like aftertreatment systems to control NO_X. For this analysis, we determined that the modal operation nature of this technology to currently only be beneficial at light loads would not be appropriate for a heavy duty application purchased specifically for its high work and load capability.

- *Diesel engine improvements and diesel aftertreatment improvements*—Improved turbocharger, EGR systems, and advanced timing can provide more efficient combustion and, hence, lower fuel consumption. Aftertreatment systems are a relatively new technology on diesel vehicles and, as such, improvements are expected in coming years that allow the effectiveness of these systems to improve while reducing the fuel and reductant demands of current systems.

Types of transmission technologies considered include:

- *Eight-speed automatic transmissions*—The gear span, gear ratios, and control system are optimized for a broader range of efficient engine operating conditions.
- *High efficiency transmission*—Significant reduction of internal parasitic losses such as pumps gear bands, etc.
- *Driveline friction reduction*—Reduction in the driveline friction from improvements to bearings, seals and other machining tolerances in the axles and transfer cases.
- *Secondary axle disconnect*—Disconnecting of some rotating components in the front axle on 4wd vehicles when the secondary axle is not needed for traction.

Types of vehicle technologies considered include:

- *Low-rolling-resistance tires*—Have characteristics that reduce frictional losses associated with the energy dissipated in the deformation of the tires under load, therefore improving fuel efficiency and reducing CO_2 emissions.
- *Aerodynamic drag reduction*—is achieved by changing vehicle shape or reducing frontal area, including skirts, air dams, underbody covers, and more aerodynamic side view mirrors.
- *Mass reduction and material substitution*—Mass reduction encompasses a variety of techniques ranging from improved design and better component integration to application of lighter and higher-strength materials. Mass reduction is further compounded by reductions in engine power and ancillary systems (transmission, steering, brakes, suspension, etc.). The agencies recognize there is a range of diversity and complexity for mass reduction and material substitution technologies and there are many techniques that automotive suppliers and manufacturers are using to achieve the levels of this technology that the agencies have modeled in our analysis for this program.

Types of electrification/accessory and hybrid technologies considered include:

- *Electric power steering*—Are electrically-assisted steering systems that have advantages over traditional hydraulic power steering because it replaces a continuously operated hydraulic pump, thereby reducing parasitic losses from the accessory drive.
- *Improved accessories*—May include high efficiency alternators, electrically driven (*i.e.,* on-demand) water pumps and cooling fans. This excludes other electrical accessories such as electric oil pumps and electrically driven air conditioner compressors.
- *Mild hybrid*—A small, engine-driven (through a belt or other mechanism) electric motor/generator/battery combination to enable features such as start-stop, energy recovery, and launch assist.
- *Strong hybrid*—A powerful electric motor/generator/battery system coupled to the powertrain to enable features such as start-stop, and significant levels of launch assist, electric operation, and brake energy recovery. For HD pickups and vans, the engine coupled with the strong hybrid system would remain unchanged in power and torque to ensure vehicle performance at all times, even if the hybrid battery is depleted.
- *Air Conditioner Systems*—These technologies include improved hoses, connectors and seals for leakage control. They also include improved compressors, expansion valves, heat exchangers and the control of these components for the purposes of improving tailpipe CO_2 emissions as a result of A/C use.[342]

(5) How Did the Agencies Determine the Costs and Effectiveness of Each of These Technologies

Building on the technical analysis underlying the 2017–2025 MY light-duty vehicle rule, the 2014–2018 MY heavy-duty vehicle rule, and the 2015 NHTSA Technology Study, the agencies took a fresh look at technology cost and effectiveness values for purposes of this proposal. For costs, the agencies reconsidered both the direct (or ''piece'') costs and indirect costs of individual components of technologies. For the direct costs, the agencies followed a bill of materials (BOM) approach employed by the agencies in the light-duty rule as well as referencing costs from the 2014–2018 MY heavy-duty vehicle rule and a new cost survey performed by Tetra Tech in 2014.

For two technologies, stoichiometric gasoline direct injection (SGDI) and turbocharging with engine downsizing, the agencies relied to the extent possible on the available tear-down data and scaling methodologies used in EPA's ongoing study with FEV, Incorporated. This study consists of complete system tear-down to evaluate technologies down to the nuts and bolts to arrive at very detailed estimates of the costs associated with manufacturing them.[343]

For the other technologies, considering all sources of information and using the BOM approach, the agencies worked together intensively to determine component costs for each of the technologies and build up the costs accordingly. Where estimates differ between sources, we have used engineering judgment to arrive at what we believe to be the best cost estimate available today, and explained the basis for that exercise of judgment.

Once costs were determined, they were adjusted to ensure that they were all expressed in 2012 dollars (see Section IX.B.1.e of this preamble), and indirect costs were accounted for using a methodology consistent with the new ICM approach developed by EPA and used in the Phase 1 rule, and the 2012–2016 and 2017–2025 light-duty rules. NHTSA and EPA also reconsidered how costs should be adjusted by modifying or scaling content assumptions to account for differences across the range of vehicle sizes and functional requirements, and adjusted the associated material cost impacts to account for the revised content. We present the individual technology costs used in this analysis in Chapter 2.12 of the Draft RIA.

Regarding estimates for technology effectiveness, the agencies used the estimates from the 2014 Southwest Research Institute study as a baseline, which was designed specifically to inform this rulemaking. In addition, the agencies used 2017–2025 light-duty rule as a reference, and adjusted these estimates as appropriate, taking into account the unique requirement of the heavy-duty test cycles to test at curb weight plus half payload versus the light-duty requirement of curb plus 300

[342] *See* Draft RIA Chapter 2.3 for more detailed technology descriptions.

[343] U.S. Environmental Protection Agency, ''Draft Report—Light-Duty Technology Cost Analysis Pilot Study,'' Contract No. EP–C–07–069, Work Assignment 1–3, September 3, 2009.

lb. The adjustments were made on an individual technology basis by assessing the specific impact of the added load on each technology when compared to the use of the technology on a light-duty vehicle. The agencies also considered other sources such as the 2010 NAS Report, recent CAFE compliance data, and confidential manufacturer estimates of technology effectiveness. The agencies reviewed effectiveness information from the multiple sources for each technology and ensured that such effectiveness estimates were based on technology hardware consistent with the BOM components used to estimate costs. Together, the agencies compared the multiple estimates and assessed their validity, taking care to ensure that common BOM definitions and other vehicle attributes such as performance and drivability were taken into account.

The agencies note that the effectiveness values estimated for the technologies may represent average values applied to the baseline fleet described earlier, and do not reflect the potentially limitless spectrum of possible values that could result from adding the technology to different vehicles. For example, while the agencies have estimated an effectiveness of 0.5 percent for low friction lubricants, each vehicle could have a unique effectiveness estimate depending on the baseline vehicle's oil viscosity rating. Similarly, the reduction in rolling resistance (and thus the improvement in fuel efficiency and the reduction in CO_2 emissions) due to the application of LRR tires depends not only on the unique characteristics of the tires originally on the vehicle, but on the unique characteristics of the tires being applied, characteristics which must be balanced between fuel efficiency, safety, and performance. Aerodynamic drag reduction is much the same—it can improve fuel efficiency and reduce CO_2 emissions, but it is also highly dependent on vehicle-specific functional objectives. For purposes of this proposed rule, the agencies believe that employing average values for technology effectiveness estimates is an appropriate way of recognizing the potential variation in the specific benefits that individual manufacturers (and individual vehicles) might obtain from adding a fuel-saving technology.

The following contains a description of technologies the agencies considered in the analysis for this proposal.

(a) Engine Technologies

The agencies reviewed the engine technology estimates used in the 2017–2025 light-duty rule, the 2014–2018 heavy-duty rule, and the 2015 NHTSA Technology Study. In doing so the agencies reconsidered all available sources and updated the estimates as appropriate. The section below describes both diesel and gasoline engine technologies considered for this program.

(i) Low Friction Lubricants

One of the most basic methods of reducing fuel consumption in both gasoline and diesel engines is the use of lower viscosity engine lubricants. More advanced multi-viscosity engine oils are available today with improved performance in a wider temperature band and with better lubricating properties. This can be accomplished by changes to the oil base stock (*e.g.,* switching engine lubricants from a Group I base oils to lower-friction, lower viscosity Group III synthetic) and through changes to lubricant additive packages (*e.g.,* friction modifiers and viscosity improvers). The use of 5W–30 motor oil is now widespread and auto manufacturers are introducing the use of even lower viscosity oils, such as 5W–20 and 0W–20, to improve cold-flow properties and reduce cold start friction. However, in some cases, changes to the crankshaft, rod and main bearings and changes to the mechanical tolerances of engine components may be required. In all cases, durability testing would be required to ensure that durability is not compromised. The shift to lower viscosity and lower friction lubricants will also improve the effectiveness of valvetrain technologies such as cylinder deactivation, which rely on a minimum oil temperature (viscosity) for operation.

(ii) Engine Friction Reduction

In addition to low friction lubricants, manufacturers can also reduce friction and improve fuel consumption by improving the design of both diesel and gasoline engine components and subsystems. Approximately 10 percent of the energy consumed by a vehicle is lost to friction, and just over half is due to frictional losses within the engine.[344] Examples include improvements in low-tension piston rings, piston skirt design, roller cam followers, improved crankshaft design and bearings, material coatings, material substitution, more optimal thermal management, and piston and cylinder surface treatments. Additionally, as computer-aided modeling software continues to improve, more opportunities for evolutionary friction reductions may become available. All reciprocating and rotating components in the engine are potential candidates for friction reduction, and minute improvements in several components can add up to a measurable fuel efficiency improvement.

(iii) Engine Parasitic Demand Reduction

In addition to physical engine friction reduction, manufacturers can reduce the mechanical load on the engine from parasitics, such as oil, fuel, and coolant pumps. The high-pressure fuel pumps of direct-injection gasoline and diesel engines have particularly high demand. Example improvements include variable speed or variable displacement water pumps, variable displacement oil pumps, more efficient high pressure fuel pumps, valvetrain upgrades and shutting off piston cooling when not needed.

(iv) Coupled Cam Phasing

Valvetrains with coupled (or coordinated) cam phasing can modify the timing of both the inlet valves and the exhaust valves an equal amount by phasing the camshaft of an overhead valve engine.[345] For overhead valve engines, which have only one camshaft to actuate both inlet and exhaust valves, couple cam phasing is the only variable valve timing implementation option available and requires only one cam phaser.[346]

(v) Cylinder Deactivation

In conventional spark-ignited engines throttling the airflow controls engine torque output. At partial loads, efficiency can be improved by using cylinder deactivation instead of throttling. Cylinder deactivation can improve engine efficiency by disabling or deactivating (usually) half of the cylinders when the load is less than half of the engine's total torque capability—the valves are kept closed, and no fuel is injected—as a result, the trapped air

[344] "Impact of Friction Reduction Technologies on Fuel Economy," Fenske, G. Presented at the March 2009 Chicago Chapter Meeting of the 'Society of Tribologists and Lubricated Engineers' Meeting, March 18th, 2009. Available at: *http://www.chicagostle.org/program/2008–2009/Impact%20of%20Friction%20Reduction%20Technologies%20on%20Fuel%20Economy%20-%20with%20VGs%20removed.pdf* (last accessed July 9, 2009).

[345] Although couple cam phasing appears only in the single overhead cam and overhead valve branches of the decision tree, it is noted that a single phaser with a secondary chain drive would allow couple cam phasing to be applied to direct overhead cam engines. Since this would potentially be adopted on a limited number of direct overhead cam engines NHTSA did not include it in that branch of the decision tree.

[346] It is also noted that coaxial camshaft developments would allow other variable valve timing options to be applied to overhead valve engines. However, since they would potentially be adopted on a limited number of overhead valve engines, NHTSA did not include them in the decision tree.

within the deactivated cylinders is simply compressed and expanded as an air spring, with reduced friction and heat losses. The active cylinders combust at almost double the load required if all of the cylinders were operating. Pumping losses are significantly reduced as long as the engine is operated in this ''part-cylinder'' mode.

Cylinder deactivation control strategy relies on setting maximum manifold absolute pressures or predicted torque within a range in which it can deactivate the cylinders. Noise and vibration issues reduce the operating range to which cylinder deactivation is allowed, although manufacturers are exploring vehicle changes that enable increasing the amount of time that cylinder deactivation might be suitable. Some manufacturers may choose to adopt active engine mounts and/or active noise cancellations systems to address Noise Vibration and Harshness (NVH) concerns and to allow a greater operating range of activation.

Cylinder deactivation has seen a recent resurgence thanks to better valvetrain designs and engine controls. General Motors and Chrysler Group have incorporated cylinder deactivation across a substantial portion of their V8-powered lineups.

(vi) Stoichiometric Gasoline Direct Injection

SGDI engines inject fuel at high pressure directly into the combustion chamber (rather than the intake port in port fuel injection). SGDI requires changes to the injector design, an additional high pressure fuel pump, new fuel rails to handle the higher fuel pressures and changes to the cylinder head and piston crown design. Direct injection of the fuel into the cylinder improves cooling of the air/fuel charge within the cylinder, which allows for higher compression ratios and increased thermodynamic efficiency without the onset of combustion knock. Recent injector design advances, improved electronic engine management systems and the introduction of multiple injection events per cylinder firing cycle promote better mixing of the air and fuel, enhance combustion rates, increase residual exhaust gas tolerance and improve cold start emissions. SGDI engines achieve higher power density and match well with other technologies, such as boosting and variable valvetrain designs.

Several manufacturers have recently introduced vehicles with SGDI engines, including GM and Ford and have announced their plans to increase dramatically the number of SGDI engines in their portfolios.

(vii) Turbocharging and Downsizing

The specific power of a naturally aspirated engine is primarily limited by the rate at which the engine is able to draw air into the combustion chambers. Turbocharging and supercharging (grouped together here as boosting) are two methods to increase the intake manifold pressure and cylinder charge-air mass above naturally aspirated levels. Boosting increases the airflow into the engine, thus increasing the specific power level, and with it the ability to reduce engine displacement while maintaining performance. This effectively reduces the pumping losses at lighter loads in comparison to a larger, naturally aspirated engine.

Almost every major manufacturer currently markets a vehicle with some form of boosting. While boosting has been a common practice for increasing performance for several decades, turbocharging has considerable potential to improve fuel economy and reduce CO_2 emissions when the engine displacement is also reduced. Specific power levels for a boosted engine often exceed 100 hp/L, compared to average naturally aspirated engine power densities of roughly 70 hp/L. As a result, engines can be downsized roughly 30 percent or higher while maintaining similar peak output levels. In the last decade, improvements to turbocharger turbine and compressor design have improved their reliability and performance across the entire engine operating range. New variable geometry turbines and ball-bearing center cartridges allow faster turbocharger spool-up (virtually eliminating the once-common ''turbo lag'') while maintaining high flow rates for increased boost at high engine speeds. Low speed torque output has been dramatically improved for modern turbocharged engines. However, even with turbocharger improvements, maximum engine torque at very low engine speed conditions, for example launch from standstill, is increased less than at mid and high engine speed conditions. The potential to downsize engines may be less on vehicles with low displacement to vehicle mass ratios for example a very small displacement engine in a vehicle with significant curb weight, in order to provide adequate acceleration from standstill, particularly up grades or at high altitudes.

The use of GDI in combination with turbocharging and charge air cooling reduces the fuel octane requirements for knock limited combustion enabling the use of higher compression ratios and boosting pressures. Recently published data with advanced spray-guided injection systems and more aggressive engine downsizing targeted towards reduced fuel consumption and CO_2 emissions reductions indicate that the potential for reducing CO_2 emissions for turbocharged, downsized GDI engines may be as much as 15 to 30 percent relative to port-fuel-injected engines.[14] [15] [16] [17] [18] Confidential manufacturer data suggests an incremental range of fuel consumption and CO_2 emission reduction of 4.8 to 7.5 percent for turbocharging and downsizing. Other publicly-available sources suggest a fuel consumption and CO_2 emission reduction of 8 to 13 percent compared to current-production naturally-aspirated engines without friction reduction or other fuel economy technologies: a joint technical paper by Bosch and Ricardo suggesting fuel economy gain of 8 to 10 percent for downsizing from a 5.7 liter port injection V8 to a 3.6 liter V6 with direct injection using a wall-guided direct injection system; a Renault report suggesting a 11.9 percent NEDC fuel consumption gain for downsizing from a 1.4 liter port injection in-line 4-cylinder engine to a 1.0 liter in-line 4-cylinder engine, also with wall-guided direct injection; and a Robert Bosch paper suggesting a 13 percent NEDC gain for downsizing to a turbocharged DI engine, again with wall-guided injection. These reported fuel economy benefits show a wide range depending on the SGDI technology employed.

Note that for this analysis we determined that this technology path is only applicable to heavy duty applications that have operating conditions more closely associated with light duty vehicles. This includes vans designed mainly for cargo volume or modest payloads having similar GCWR to light duty applications. These vans cannot tow trailers heavier than similar light duty vehicles and are largely already sharing engines of significantly smaller displacement and cylinder count compared to heavy duty vehicles designed mainly for trailer towing.

(viii) Cooled Exhaust-Gas Recirculation

Cooled exhaust gas recirculation or Boosted EGR is a combustion concept that involves utilizing EGR as a charge diluent for controlling combustion temperatures and cooling the EGR prior to its introduction to the combustion system. Higher exhaust gas residual levels at part load conditions reduce pumping losses for increased fuel economy. The additional charge dilution enabled by cooled EGR reduces the incidence of knocking combustion and obviates the need for fuel enrichment at high engine power. This allows for higher boost pressure and/or compression ratio and further reduction in engine displacement and both pumping and friction losses while maintaining performance. Engines of this type use GDI and both dual cam phasing and discrete variable valve lift. The EGR systems considered in this proposed rule, consistent with the proposal, would use a dual-loop system with both high and low pressure EGR loops and dual EGR coolers. The engines would also use single-stage, variable geometry turbocharging with higher intake boost pressure available across a broader range of engine operation than conventional turbocharged SI engines. Such a system is estimated to be capable of an additional 3 to 5 percent effectiveness relative to a turbocharged, downsized GDI engine without cooled-EGR. The agencies have also considered a more advanced version of such a cooled EGR system that employs very high combustion pressures by using dual stage turbocharging.

(b) Diesel Engine Technologies

Diesel engines have several characteristics that give them superior fuel efficiency compared to conventional gasoline, spark-ignited engines. Pumping losses are much lower due to lack of (or greatly reduced) throttling. The diesel combustion cycle operates at a higher compression ratio, with a very lean air/fuel mixture, and turbocharged light-duty diesels typically achieve much higher torque levels at lower engine speeds than equivalent-displacement naturally-aspirated gasoline engines. Additionally, diesel fuel has a higher energy content per gallon.[347] However, diesel fuel also has a higher carbon to hydrogen ratio, which increases the amount of CO_2 emitted per gallon of fuel used by approximately 15 percent over a gallon of gasoline.

Based on confidential business information and the 2010 NAS Report, two major areas of diesel engine design could be improved during the timeframe of this proposed rule. These areas include aftertreatment improvements and a broad range of engine improvements.

(i) Aftertreatment Improvements

The HD diesel pickup and van segment has largely adopted the SCR type of aftertreatment system to comply with criteria pollutant emission standards. As the experience base for SCR expands over the next few years, many improvements in this aftertreatment system such as construction of the catalyst, thermal management, and reductant optimization may result in a reduction in the amount of fuel used in the process. However, due to uncertainties with these improvements regarding the extent of current optimization and future criteria emissions obligations, the agencies are not considering aftertreatment improvements as a fuel-saving technology in the rulemaking analysis.

(ii) Engine Improvements

Diesel engines in the HD pickup and van segment are expected to have several improvements in their base design in the 2021–2027 timeframe. These improvements include items such as improved combustion management, optimal turbocharger design, and improved thermal management.

(c) Transmission Technologies

The agencies have also reviewed the transmission technology estimates used in the 2017–2015 light-duty and 2014–2018 heavy-duty final rules. In doing so, NHTSA and EPA considered or reconsidered all available sources including the 2015 NHTSA Technology Study and updated the estimates as appropriate. The section below describes each of the transmission technologies considered for the proposal.

(i) Automatic 8-Speed Transmissions

Manufacturers can also choose to replace 6-speed automatic transmissions with 8-speed automatic transmissions. Additional ratios allow for further optimization of engine operation over a wider range of conditions, but this is subject to diminishing returns as the number of speeds increases. As additional gear sets are added, additional weight and friction are introduced requiring additional countermeasures to offset these losses. Some manufacturers are replacing 6-speed automatics already, and 7- and 8-speed automatics have entered production.

(ii) High Efficiency Transmission

For this proposal, a high efficiency transmission refers to some or all of a suite of incremental transmission improvement technologies that should be available within the 2019 to 2027 timeframe. The majority of these improvements address mechanical friction within the transmission. These improvements include but are not limited to: shifting clutch technology improvements, improved kinematic design, dry sump lubrication systems, more efficient seals, bearings and clutches (reducing drag), component superfinishing and improved transmission lubricants.

(d) Electrification/Accessory Technologies

(i) Electrical Power Steering or Electrohydraulic Power Steering

Electric power steering (EPS) or Electrohydraulic power steering (EHPS) provides a potential reduction in CO_2 emissions and fuel consumption over hydraulic power steering because of reduced overall accessory loads. This eliminates the parasitic losses associated with belt-driven power steering pumps which consistently draw load from the engine to pump hydraulic fluid through the steering actuation systems even when the wheels are not being turned. EPS is an enabler for all vehicle hybridization technologies since it provides power steering when the engine is off. EPS may be implemented on most vehicles with a standard 12V system. Some heavier vehicles may require a higher voltage system which may add cost and complexity.

(ii) Improved Accessories

The accessories on an engine, including the alternator, coolant and oil pumps are traditionally mechanically-driven. A reduction in CO_2 emissions and fuel consumption can be realized by driving them electrically, and only when needed (''on-demand'').

Electric water pumps and electric fans can provide better control of engine cooling. For example, coolant flow from an electric water pump can be reduced and the radiator fan can be shut off during engine warm-up or cold ambient temperature conditions which will reduce warm-up time, reduce warm-up fuel enrichment, and reduce parasitic losses.

Indirect benefit may be obtained by reducing the flow from the water pump electrically during the engine warm-up period, allowing the engine to heat more rapidly and thereby reducing the fuel enrichment needed during cold operation and warm-up of the engine. Faster oil warm-up may also result from better management of the coolant warm-up period. Further benefit may be obtained when electrification is combined with an improved, higher efficiency engine alternator used to supply power to the electrified accessories.

Intelligent cooling can more easily be applied to vehicles that do not typically

[347] Burning one gallon of diesel fuel produces about 15 percent more carbon dioxide than gasoline due to the higher density and carbon to hydrogen ratio.

carry heavy payloads, so larger vehicles with towing capacity present a challenge, as these vehicles have high cooling fan loads.[348] However, towing vehicles tend to have large cooling system capacity and flow scaled to required heat rejection levels when under full load situations such as towing at GCWR in extreme ambient conditions. During almost all other situations, this design characteristic may result in unnecessary energy usage for coolant pumping and heat rejection to the radiator.

The agencies considered whether to include electric oil pump technology for the rulemaking. Because it is necessary to operate the oil pump any time the engine is running, electric oil pump technology has insignificant effect on efficiency. Therefore, the agencies decided to not include electric oil pump technology.

(iii) Mild Hybrid

Mild hybrid systems offer idle-stop functionality and a limited level of regenerative braking and power assist. These systems replace the conventional alternator with a belt or crank driven starter/alternator and may add high voltage electrical accessories (which may include electric power steering and an auxiliary automatic transmission pump). The limited electrical requirements of these systems allow the use of lead-acid batteries or supercapacitors for energy storage, or the use of a small lithium-ion battery pack.

(iv) Strong Hybrid

A hybrid vehicle is a vehicle that combines two significant sources of propulsion energy, where one uses a consumable fuel (like gasoline), and one is rechargeable (during operation, or by another energy source). Hybrid technology is well established in the U.S. light-duty market and more manufacturers are adding hybrid models to their lineups. Hybrids reduce fuel consumption through three major mechanisms:

- The internal combustion engine can be optimized (through downsizing, modifying the operating cycle, or other control techniques) to operate at or near its most efficient point more of the time. Power loss from engine downsizing can be mitigated by employing power assist from the secondary power source.
- A significant amount of the energy normally lost as heat while braking can be captured and stored in the energy storage system for later use.
- The engine is turned off when it is not needed, such as when the vehicle is coasting or when stopped.

Hybrid vehicles utilize some combination of the three above mechanisms to reduce fuel consumption and CO_2 emissions. The effectiveness of fuel consumption and CO_2 reduction depends on the utilization of the above mechanisms and how aggressively they are pursued. One area where this variation is particularly prevalent is in the choice of engine size and its effect on balancing fuel economy and performance. Some manufacturers choose not to downsize the engine when applying hybrid technologies. In these cases, overall performance (acceleration) is typically improved beyond the conventional engine. However, fuel efficiency improves less than if the engine was downsized to maintain the same performance as the conventional version. The non-downsizing approach is used for vehicles like trucks where towing and/or hauling are an integral part of their performance requirements. In these cases, if the engine is downsized, the battery can be quickly drained during a long hill climb with a heavy load, leaving only a downsized engine to carry the entire load. Because towing capability is currently a heavily-marketed truck attribute, manufacturers are hesitant to offer a truck with downsized engine which can lead to a significantly diminished towing performance when the battery state of charge level is low, and therefore engines are traditionally not downsized for these vehicles.

Strong Hybrid technology utilizes an axial electric motor connected to the transmission input shaft and connected to the engine crankshaft through a clutch. The axial motor is a motor/generator that can provide sufficient torque for launch assist, all electric operation, and the ability to recover significant levels of braking energy.

(e) Vehicle Technologies

(i) Mass Reduction

Mass reduction is a technology that can be used in a manufacturer's strategy to meet the Heavy Duty Greenhouse Gas Phase 2 standards. Vehicle mass reduction (also referred to as ''down-weighting'' or 'light-weighting''), decreases fuel consumption and GHG emissions by reducing the energy demand needed to overcome inertia forces, and rolling resistance. Automotive companies have worked with mass reduction technologies for many years and a lot of these technologies have been used in production vehicles. The weight savings achieved by adopting mass reduction technologies offset weight gains due to increased vehicle size, larger powertrains, and increased feature content (sound insulation, entertainment systems, improved climate control, panoramic roof, etc.). Sometimes mass reduction has been used to increase vehicle towing and payload capabilities.

Manufacturers employ a systematic approach to mass reduction, where the net mass reduction is the addition of a direct component or system mass reduction, also referred to as primary mass reduction, plus the additional mass reduction taken from indirect ancillary systems and components, also referred to as secondary mass reduction or mass compounding. There are more secondary mass reductions achievable for light-duty vehicles compared to heavy-duty vehicles, which are limited due to the higher towing and payload requirements for these vehicles.

Mass reduction can be achieved through a number of approaches, even while maintaining other vehicle functionalities. As summarized by NAS in its 2011 light duty vehicle report,[349] there are two key strategies for primary mass reduction: (1) Changing the design to use less material; (2) substituting lighter materials for heavier materials.

The first key strategy of using less material compared to the baseline component can be achieved by optimizing the design and structure of vehicle components, systems and vehicle structure. Vehicle manufacturers have long used these continually-improving CAE tools to optimize vehicle designs. For example, the Future Steel Vehicle (FSV) project[350] sponsored by WorldAutoSteel used three levels of optimization: topology optimization, low fidelity 3G (Geometry Grade and Gauge) optimization, and subsystem optimization, to achieve 30 percent mass reduction in the body structure of a vehicle with a mild steel unibody structure. Using less material can also be achieved through improving the manufacturing process, such as by using improved joining technologies and parts consolidation. This method is

[348] In the CAFE model, improved accessories refers solely to improved engine cooling. However, EPA has included a high efficiency alternator in this category, as well as improvements to the cooling system.

[349] Committee on the Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy; National Research Council, ''Assessment of Fuel Economy Technologies for Light-Duty Vehicles'', 2011. Available at *http://www.nap.edu/catalog.php?record_id=12924* (last accessed Jun 27, 2012).

[350] SAE World Congress, ''Focus B-pillar 'tailor rolled' to 8 different thicknesses,'' Feb. 24, 2010. Available at *http://www.sae.org/mags/AEI/7695* (last accessed Jun. 10, 2012).

often used in combination with applying new materials.

The second key strategy to reduce mass of an assembly or component involves the substitution of lower density and/or higher strength materials. Material substitution includes replacing materials, such as mild steel, with higher-strength and advanced steels, aluminum, magnesium, and composite materials. In practice, material substitution tends to be quite specific to the manufacturer and situation. Some materials work better than others for particular vehicle components, and a manufacturer may invest more heavily in adjusting to a particular type of advanced material, thus complicating its ability to consider others. The agencies recognize that like any type of mass reduction, material substitution has to be conducted not only with consideration to maintaining equivalent component strength, but also to maintaining all the other attributes of that component, system or vehicle, such as crashworthiness, durability, and noise, vibration and harshness (NVH).

If vehicle mass is reduced sufficiently through application of the two primary strategies of using less material and material substitution described above, secondary mass reduction options may become available. Secondary mass reduction is enabled when the load requirements of a component are reduced as a result of primary mass reduction. If the primary mass reduction reaches a sufficient level, a manufacturer may use a smaller, lighter, and potentially more efficient powertrain while maintaining vehicle acceleration performance. If a powertrain is downsized, a portion of the mass reduction may be attributed to the reduced torque requirement which results from the lower vehicle mass. The lower torque requirement enables a reduction in engine displacement, changes to transmission torque converter and gear ratios, and changes to final drive gear ratio. The reduced powertrain torque enables the downsizing and/or mass reduction of powertrain components and accompanying reduced rotating mass (*e.g.,* for transmission, driveshafts/halfshafts, wheels, and tires) without sacrificing powertrain durability. Likewise, the combined mass reductions of the engine, drivetrain, and body in turn reduce stresses on the suspension components, steering components, wheels, tires, and brakes, which can allow further reductions in the mass of these subsystems. Reducing the unsprung masses such as the brakes, control arms, wheels, and tires further reduce stresses in the suspension mounting points, which will allow for further optimization and potential mass reduction. However, pickup trucks have towing and hauling requirements which must be taken into account when determining the amount of secondary mass reduction that is possible and so it is less than that of passenger cars.

Ford's MY 2015 F–150 is one example of a light duty manufacturer who has begun producing high volume vehicles with a significant amount of mass reduction identified, specifically 250 to 750 lb per vehicle [351]. The vehicle is an aluminum intensive design and includes an aluminum cab structure, body panels, and suspension components, as well as a high strength steel frame and a smaller, lighter and more efficient engine. The Executive Summary to Ducker Worldwide's 2014 report [352] states that state that the MY 2015 F–150 contains 1080 lbs of aluminum with at least half of this being aluminum sheet and extrusions for body and closures. Ford engine range for its light duty truck fleet includes a 2.7L EcoBoost V–6. It is possible that the strategy of aluminum body panels will be applied to the heavy duty F–250 and F–350 versions when they are redesigned.[353]

EPA recently completed a multi-year study with FEV North America, Inc. on the lightweighting of a light-duty pickup truck, a 2011 GMC Silverado, titled ''Mass Reduction and Cost Analysis –Light-Duty Pickup Trucks Model Years 2020–2025.'' [354] Results contain a cost curve for various mass reduction percentages with the main solution being evaluated for a 21.4 percent (511 kg/1124 lb) mass reduction resulting in an increased direct incremental manufacturing cost of $2228. In addition, the report outlines the compounding effect that occurs in a vehicle with performance requirements including hauling and towing. Secondary mass evaluation was performed on a component level based on an overall 20 percent vehicle mass reduction. Results revealed 84 kg of the 511 kg, or 20 percent, were from secondary mass reduction. Information on this study is summarized in SAE paper 2015–01–0559. DOT has also sponsored an on-going pickup truck lightweighting project. This project uses a more recent baseline vehicle, a MY 2014 GMC Silverado, and the project will be finished by early 2016. Both projects will be utilized for the light-duty GHG and CAFE Midterm Evaluation mass reduction baseline characterization and may be used to update assumptions of mass reduction for HD pickups and vans for the final Phase 2 rulemaking.

In order to determine if technologies identified on light duty trucks are applicable to heavy-duty pickups, EPA also contracted with FEV North America, Inc. to perform a scaling study in order to evaluate the technologies identified for the light-duty truck would be applicable for a heavy-duty pickup truck, in this study a Silverado 2500, a Mercedes Sprinter and a Renault Master. This report is currently being drafted and will be peer reviewed and finalized between the proposed rule and the final rule making. The specific results will be presented in the final rulemaking (FRM) and may be used to update assumptions of mass reduction for the FRM.

The RIA for this rulemaking shows that mass reduction is assumed to be part of the strategy for compliance for HD pickups and vans. The assumptions of mass reduction for HD pickups and vans as used in this analysis were taken from the recent light-duty fuel economy/GHG rulemaking for light-duty pickup trucks, though they may be updated for the FRM based upon the on-going EPA and NHTSA lightweighting studies as well as other information received in the interim. The cost and effectiveness assumptions for mass reduction technology are described in the RIA.

(ii) Low Rolling Resistance Tires

Tire rolling resistance is the frictional loss associated mainly with the energy dissipated in the deformation of the tires under load and thus influences fuel efficiency and CO_2 emissions. Other tire design characteristics (*e.g.,* materials, construction, and tread design) influence durability, traction (both wet and dry grip), vehicle handling, and ride comfort in addition to rolling resistance. A typical LRR tire's attributes would include: Increased tire inflation pressure, material changes, and tire construction with less hysteresis, geometry changes (*e.g.,* reduced aspect ratios), and reduction in sidewall and tread deflection. These changes would generally be accompanied with

[351] ''2008/9 Blueprint for Sustainability,'' Ford Motor Company. Available at: *http://www.ford.com/go/sustainability* (last accessed February 8, 2010).

[352] ''2015 North American Light Vehicle Aluminum Content Study—Executive Summary'', June 2014, *http://www.drivealuminum.org/research-resources/PDF/Research/2014/2014-ducker-report* (last accessed February 26, 2015).

[353] *http://www.foxnews.com/leisure/2014/09/30/ford-confirms-increased-aluminum-use-on-next-gen-super-duty-pickups/.*

[354] ''Mass Reduction and Cost Analysis—Light-Duty Pickup Trucks Model Years 2020–2025'', FEV, North America, Inc., April 2015, Document no. EPA–420–R–15–006.

additional changes to suspension tuning and/or suspension design.

(iii) Aerodynamic Drag Reduction

Many factors affect a vehicle's aerodynamic drag and the resulting power required to move it through the air. While these factors change with air density and the square and cube of vehicle speed, respectively, the overall drag effect is determined by the product of its frontal area and drag coefficient, Cd. Reductions in these quantities can therefore reduce fuel consumption and CO_2 emissions. Although frontal areas tend to be relatively similar within a vehicle class (mostly due to market-competitive size requirements), significant variations in drag coefficient can be observed. Significant changes to a vehicle's aerodynamic performance may need to be implemented during a redesign (*e.g.,* changes in vehicle shape). However, shorter-term aerodynamic reductions, with a somewhat lower effectiveness, may be achieved through the use of revised exterior components (typically at a model refresh in mid-cycle) and add-on devices that currently being applied. The latter list would include revised front and rear fascias, modified front air dams and rear valances, addition of rear deck lips and underbody panels, and lower aerodynamic drag exterior mirrors.

(6) What Are the Projected Technology Effectiveness Values and Costs

The assessment of the technology effectiveness and costs was determined from a combination of sources. First an assessment was performed by SwRI under contract with the agencies to determine the effectiveness and costs on several technologies that were generally not considered in the Phase 1 GHG rule time frame. Some of the technologies were common with the light-duty assessment but the effectiveness and costs of individual technologies were appropriately adjusted to match the expected effectiveness and costs when implemented in a heavy-duty application. Finally, the agencies performed extensive outreach to suppliers of engine, transmission and vehicle technologies applicable to heavy-duty applications to get industry input on cost and effectiveness of potential GHG and fuel consumption reducing technologies.

To achieve the levels of the proposed standards for gasoline and diesel powered heavy-duty vehicles, a combination of the technologies previously discussed would be required respective to unique gasoline and diesel technologies and their challenges. Although some of the technologies may already be implemented in a portion of heavy-duty vehicles, none of the technologies discussed are considered ubiquitous in the heavy-duty fleet. Also, as would be expected, the available test data show that some vehicle models would not need the full complement of available technologies to achieve the proposed standards. Furthermore, many technologies can be further improved (*e.g.,* aerodynamic improvements) from today's best levels, and so allow for compliance without needing to apply a technology that a manufacturer might deem less desirable.

Technology costs for HD pickups and vans are shown in Table VI–4. These costs reflect direct and indirect costs to the vehicle manufacturer for the 2021 model year. See Chapter 2 of the Draft RIA for a more complete description of the basis of these costs.

TABLE VI–4—TECHNOLOGY COSTS FOR HD PICKUPS & VANS INCLUSIVE OF INDIRECT COST MARKUPS FOR MY2021 (2012$)

Technology	Gasoline	Diesel
Engine changes to accommodate low friction lubes	$6	$6
Engine friction reduction—level 1	116	116
Engine friction reduction—level 2	254	254
Dual cam phasing	183	183
Cylinder deactivation	196	N/A
Stoichiometric gasoline direct injection	451	N/A
Turbo improvements	N/A	16
Cooled EGR	373	373
Turbocharging & downsizing[a]	671	N/A
"Right-sized" diesel from larger diesel	N/A	0
8s automatic transmission (increment to 6s automatic transmission)	457	457
Improved accessories—level 1	82	82
Improved accessories—level 2	132	132
Low rolling resistance tires—level 1	10	10
Passive aerodynamic improvements (aero 1)	51	51
Passive plus Active aerodynamic improvements (aero2)	230	230
Electric (or electro/hydraulic) power steering	151	151
Mass reduction (10% on a 6500 lb vehicle)	318	318
Driveline friction reduction	139	139
Stop-start (no regenerative braking)	539	539
Mild HEV	2,730	2,730
Strong HEV without inclusion of any engine changes	6,779	6,779

Note:
[a] Cost to downsize from a V8 OHC to a V6 OHC engine with twin turbos.

As noted above, the CAFE model works by adding technologies in an incremental fashion to each particular vehicle in a manufacturer's fleet until that fleet complies with the imposed standards. It does this by following a predefined set of decision trees whereby the particular vehicle is placed on the appropriate decision tree and it follows the predefined progression of technology available on that tree. At each step along the tree, a decision is made regarding the cost of a given technology relative to what already exists on the vehicle along with the fuel consumption improvement it provides relative to the fuel consumption at the current location on the tree, prior to deciding whether to take that next step on the tree or remain in the current location. Because the model works in this way, the input files must be structured to provide costs and effectiveness values for each technology relative to whatever technologies have been added in earlier steps along the tree. Table VI–5 presents the cost and effectiveness values used in the CAFE model input files.

TABLE VI–5—CAFE MODEL INPUT VALUES FOR COST & EFFECTIVENESS FOR GIVEN TECHNOLOGIES [a]

Technology	FC savings (%)	Incremental cost (2012$) [a b]		
		2021	2025	2027
Improved Lubricants and Engine Friction Reduction	1.60	24	24	23
Coupled Cam Phasing (SOHC)	3.82	48	43	39
Dual Variable Valve Lift (SOHC)	2.47	42	37	34
Cylinder Deactivation (SOHC)	3.70	34	30	27
Intake Cam Phasing (DOHC)	0.00	48	43	39
Dual Cam Phasing (DOHC)	3.82	46	40	37
Dual Variable Valve Lift (DOHC)	2.47	42	37	34
Cylinder Deactivation (DOHC)	3.70	34	30	27
Stoichiometric Gasoline Direct Injection (OHC)	0.50	71	61	56
Cylinder Deactivation (OHV)	3.90	216	188	172
Variable Valve Actuation (OHV)	6.10	54	47	43
Stoichiometric Gasoline Direct Injection (OHV)	0.50	71	61	56
Engine Turbocharging and Downsizing:				
Small Gasoline Engines	8.00	518	441	407
Medium Gasoline Engines	8.00	−12	−62	−44
Large Gasoline Engines	8.00	623	522	456
Cooled Exhaust Gas Recirculation	3.04	382	332	303
Cylinder Deactivation on Turbo/downsized Eng.	1.70	33	29	26
Lean-Burn Gasoline Direct Injection	4.30	1,758	1,485	1,282
Improved Diesel Engine Turbocharging	2.51	22	19	18
Engine Friction & Parasitic Reduction:				
Small Diesel Engines	3.50	269	253	213
Medium Diesel Engines	3.50	345	325	273
Large Diesel Engines	3.50	421	397	334
Downsizing of Diesel Engines (V6 to I–4)	11.10	0	0	0
8-Speed Automatic Transmission [c]	5.00	482	419	382
Electric Power Steering	1.00	160	144	130
Improved Accessories (Level 1)	0.93	93	83	75
Improved Accessories (Level 2)	0.93	57	54	46
Stop-Start System	1.10	612	517	446
Integrated Starter-Generator	3.20	1,040	969	760
Strong Hybrid Electric Vehicle	17.20	3,038	2,393	2,133
Mass Reduction (5%)	1.50	0.28	0.24	0.21
Mass Reduction (additional 5%)	1.50	0.87	0.75	0.66
Reduced Rolling Resistance Tires	1.10	10	9	9
Low-Drag Brakes	0.40	106	102	102
Driveline Friction Reduction	0.50	153	137	124
Aerodynamic Improvements (10%)	0.70	58	52	47
Aerodynamic Improvements (add'l 10%)	0.70	193	182	153

Notes:
[a] Values for other model years available in CAFE model input files available at NHTSA Web site.
[b] For mass reduction, cost reported on mass basis (per pound of curb weight reduction).
[c] 8 speed automatic transmission costs include costs for high efficiency gearbox and aggressive shift logic whereas those costs were kept separate in prior analyses.

(7) Summary of Alternatives Analysis

The major outputs of the CAFE model analysis are summarized in Table VI–6 and Table VI–7 below for the flat and dynamic baselines, respectively. For a more detailed analysis of the alternatives, please refer to Section D below as well as the draft RIA.

TABLE VI–6—SUMMARY OF HD PICKUP AND VAN ALTERNATIVES' ANALYSIS—METHOD A USING THE FLAT BASELINE [a]

Alternative	2	3	4	5
Annual Standard Increase	2.0%/y	2.5%/y	3.5%/y	4.0%/y
Stringency Increase through MY	2025	2027	2025	2025
Total Stringency Increase	9.6%	16.2%	16.3%	18.5%
Average Fuel Economy (miles per gallon)				
Required	19.05	20.58	20.58	21.14
Achieved	19.12	20.58	20.83	21.32

TABLE VI–6—SUMMARY OF HD PICKUP AND VAN ALTERNATIVES' ANALYSIS—METHOD A USING THE FLAT BASELINE [a]—Continued

Alternative	2	3	4	5
Average Fuel Consumption (gallons/100 mi.)				
Required	5.25	4.86	4.86	4.73
Achieved	5.23	4.86	4.80	4.69
Average Greenhouse Gas Emissions (g/mi)				
Required	495	458	458	446
Achieved	493	458	453	442
Incremental Technology Cost (vs. No-Action)				
Average ($/vehicle) [b]	700	1,324	1,804	2,135
Payback period (m) [b]	24	26	34	36
Total ($m)	529	1,001	1,363	1,614
Benefit-Cost Summary, MYs 2021–2030 ($billion) [c]				
Fuel Savings (bil. gal.)	6.1	10.1	11.9	13.3
CO_2 Reduction (mmt)	73	118	139	155
Total Social Cost	3.3	5.6	8.7	10.2
Total Social Benefit	18.4	29.0	34.4	37.9
Net Social Benefit	15.1	23.4	25.7	27.7

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Values also used in Method B.

[c] At a 3% discount rate.

TABLE VI–7—SUMMARY OF HD PICKUP AND VAN ALTERNATIVES' ANALYSIS—METHOD A USING THE DYNAMIC BASELINE [a]

Alternative	2	3	4	5
Annual Standard Increase	2.0%/y	2.5%/y	3.5%/y	4.0%/y
Stringency Increase through MY	2025	2027	2025	2025
Total Stringency Increase	9.6%	16.2%	16.3%	18.5%
Average Fuel Economy (miles per gallon)				
Required	19.04	20.57	20.57	21.14
Achieved	19.14	20.61	20.83	21.27
Average Fuel Consumption (gallons/100 mi.)				
Required	5.25	4.86	4.86	4.73
Achieved	5.22	4.85	4.80	4.70
Average Greenhouse Gas Emissions (g/mi)				
Required	495	458	458	446
Achieved	491	458	453	444
Incremental Technology Cost (vs. No-Action)				
Average ($/vehicle) [b]	578	1,348	1,655	2,080
Payback period (m) [b]	25	31	34	38
Total ($m)	437	1,019	1,251	1,572
Benefit-Cost Summary, MYs 2021–2030 ($billion) [c]				
Fuel Savings (bil. gal.)	5.0	8.9	10.5	11.9
CO_2 Reduction (mmt)	59	104	122	139
Total Social Cost	3.3	6.8	9.5	13.0
Total Social Benefit	14.3	23.6	28.2	32.8
Net Social Benefit	11.0	16.8	18.7	19.8

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Values also used in Method B.

[c] At a 3% discount rate.

In general, the proposed standards are projected to cause manufacturers to produce HD pickups and vans that are lighter, more aerodynamic, and more technologically complex across all the alternatives, while social benefits continue to increase across all alternatives. As shown, there is a major difference between the relatively small improvements in required fuel consumption and average incremental technology cost between the alternatives, suggesting that the challenge of improving fuel consumption and CO_2 emissions accelerates as stringency increases (*i.e.,* that there may be a ''knee'' in the dependence of the challenge and on the stringency). Despite the fact that the required average fuel consumption level only changes by 3 percent between Alternative 4 and Alternative 5, average technology cost increases by more than 25 percent.

Note further that the difference in estimated costs, effectiveness, degree of technology penetration required, and overall benefits do not vary significantly under either the flat or dynamic baseline assumptions. The agencies view these results as corroborative of the basic reasonableness of the approach proposed.

(8) Consistency of the Proposed Standards With the Agencies' Respective Legal Authorities

Based on the information currently before the agencies, we believe that Alternative 3 would be maximum feasible and appropriate for this segment for the model years in question. EPA believes this reflects a reasonable consideration of the statutory factors of technology effectiveness, feasibility, cost, lead time, and safety for purposes of CAA sections 202 (a)(1) and (2). NHTSA believes this proposal is maximum feasible under EISA. The agencies have projected a compliance path for the proposed standards showing aggressive implementation of technologies that the agencies consider to be available in the time frame of these rules. Under this approach, manufacturers are expected to implement these technologies at aggressive adoption rates on essentially all vehicles across this sector by 2027 model year. In the case of several of these technologies, adoption rates are projected to approach 100 percent. This includes a combination of engine, transmission and vehicle technologies as described in this section across every vehicle. The proposal also is premised on less aggressive penetration of particular advanced technologies, including strong hybrid electric vehicles.

We project the proposed standards to be achievable within known design cycles, and we believe these standards would allow different paths to compliance in addition to the one we outline and cost here. As discussed below and throughout this analysis, our proposal places a higher value on maintaining functionality and capability of vehicles designed for work (versus light-duty), and on the assurance of in use reliability and market acceptance of new technology, particularly in initial model years of the program. Nevertheless, it may be possible to have additional adoption rates of the technologies than we project so that further reductions could be available at reasonable cost and cost-effectiveness.

Alternative 4 is also discussed in detail below because the agencies believe it has the potential to be the maximum feasible alternative, and otherwise appropriate. The agencies could decide to adopt Alternative 4, in whole or in part, in the final rule. In particular, the agencies believe Alternative 4, which would achieve the same stringency as the proposed standards with two years less lead time, merits serious consideration. However, the agencies are uncertain whether the projected technologies and market penetration rates that could be necessary to meet the stringencies would be practicable within the lead time provided in Alternative 4. The proposed standards are generally designed to achieve the levels of fuel consumption and GHG stringency that Alternative 4 would achieve, but with several years of additional lead time, meaning that manufacturers could, in theory, apply new technology at a more gradual pace and with greater flexibility. The agencies seek comment on these alternatives, including their corresponding lead times.

Alternative 4 is based on a year-over-year increase in stringency of 3.5 percent in MYs 2021–2025 whereas the proposed preferred Alternative 3 is based on a 2.5 percent year-over-year increase in stringency in MY 2021–2027. The agencies project that the higher rate of increase in stringency associated with Alternative 4 and the shorter lead time would necessitate the use of a different technology mix under Alternative 4 compared to Alternative 3. Alternative 3 would achieve the same final stringency increase as Alternative 4 at about 80 percent of the average per-vehicle cost increase, and without the expected deployment of more advanced technology at high penetration levels. In particular, under the agencies' primary analysis that includes the use of strong hybrids manufacturers are estimated to deploy strong hybrids in approximately 8 percent of new vehicles (in MY2027) under Alternative 3, compared to 12 percent under Alternative 4 (in MY 2025). Less aggressive electrification technologies also appear on 33 percent of new vehicles simulated to be produced in MY2027 under Alternative 4, but are not necessary under Alternative 3. Additionally, it is important to note that due to the shorter lead time of Alternative 4, there are fewer vehicle refreshes and redesigns during the phase-in period of MY 2021–2025. While the CAFE model's algorithm accounts for manufacturers' consideration of upcoming stringency changes and credit carry-forward, the steeper ramp-up of the standard in Alternative 4, coupled with the five-year credit life, results in a prediction that manufacturers would take less cost-effective means to comply with the standards compared with the proposed alternative 3 phase-in period of MY 2021–2027. For example, the model predicts that some manufacturers would not implement any amount of strong hybrids on their vans during the 2021–2025 timeframe and instead would implement less effective technologies such as mild hybrids at higher rates than what would otherwise have been required if they had implemented a small percentage of strong hybrids. Whereas for Alternative 3, the longer, shallower phase-in of the standards allows for more compliance flexibility and closer matching with the vehicle redesign cycles, which (as noted above) can be up to ten years for HD vans.

There is also a high degree of sensitivity to the estimated effectiveness levels of individual technologies. At high penetration rates of all technologies on a vehicle, the result of a reduced effectiveness of even a single technology could be non-compliance with the standards. If the standards do not account for this uncertainty, there would be a real possibility that a manufacturer who followed the exact technology path we project would not meet their target because a technology performed slightly differently in their application. NHTSA has explored this uncertainty, among others, in the uncertainty analysis described in Section D below.

As discussed above, the proposed Alternative 3 standards and the Alternative 4 standards are based on the application of the technologies described in this section. These technologies are projected to be available within the lead time provided under Alternative 3—*i.e.,* by MY 2027, as discussed in Draft RIA Chapter 2.6. The proposed standards and Alternative 4 would require a relatively aggressive implementation schedule of most of these technologies during the program phase-in. Heavy-duty pickups and vans would need to have a combination of many individual technologies to achieve the proposed standards. The proposed standards are projected to yield significant emission and fuel consumption reductions without requiring a large segment transition to strong hybrids, a technology that while successful in light-duty passenger cars, cross-over vehicles and SUVs, may impact vehicle work capabilities [355] and have questionable customer acceptance in a large portion of this segment dedicated to towing.[356]

Table VI–8 below shows that the agencies' analysis estimates that the most cost-effective way to meet the requirements of Alternative 3 would be to use strong hybrids in up to 9.9 percent of pickups and 5.5 percent of vans on an industry-wide basis whereas Alternative 4 shows strong hybrids on up to 19 percent of pickups. The analysis shows that the two years of additional lead time provided by the proposed Alternative 3 would provide manufacturers with a better opportunity to maximize the use of more cost effective technologies over time thereby reducing the need for strong hybrids which may be particularly challenging for this market segment. The agencies seek comment on the potential use of technologies in response to Alternatives 3 and 4, as well as the corresponding lead times proposed in each alternative.

TABLE VI–8—CAFE MODEL TECHNOLOGY ADOPTION RATES FOR PROPOSAL AND ALTERNATIVE 4 SUMMARY—FLAT BASELINE

Technology	Proposal (2.5% per year) 2021 to 2027		Alternative 4 (3.5% per year) 2021 to 2025	
	Pickup trucks (%)	Vans (%)	Pickup trucks (%)	Vans (%)
Low friction lubricants	100	100	100	100
Engine friction reduction	100	100	100	100
Cylinder deactivation	22	19	22	19
Variable valve timing	22	82	22	82
Gasoline direct injection	0	63	0	80
Diesel engine improvements	60	3.6	60	3.6
Turbo downsized engine	0	63	0	63
8 speed transmission	98	92	98	92
Low rolling resistance tires	100	92	100	59
Aerodynamic drag reduction	100	100	100	100
Mass reduction and materials	100	100	100	100
Electric power steering	100	49	100	46
Improved accessories	100	87	100	36
Low drag brakes	100	45	100	45
Stop/start engine systems	0	0	15	1.5
Mild hybrid	0	0	29	15
Strong hybrid	9.9	5.5	19	0

As discussed earlier, the agencies also conducted a sensitivity analysis to determine a compliance pathway where no strong hybrids would be selected. Although the agencies project that strong hybrids may be the most cost effective approach, manufacturers may select another compliance path. This no strong hybrid analysis included the use of downsized turbocharged engine in vans currently equipped with large V–8 engines. Turbo-downsized engines were not allowed on 6+ liter gasoline vans in the primary analysis because the agencies sought to preserve consumer choice with respect to vans that have large V–8s for towing. However, given the recent introduction of vans with considerable towing capacity and turbo-downsized engines, the agencies believe it would be feasible for vans in the time-frame of these proposed rules. Table VI–9 below reflects the difference in penetration rates of technologies for the proposal and Alternative 4 if strong hybridization is not chosen as a technology pathway. For simplicity, pickup trucks and vans are combined into a single industry wide penetration rate. While strong hybridization may provide the most cost effective path for a manufacturer to comply with the Proposal or Alternative 4, there are other means to comply with the requirements, mainly a 20 percent penetration rate of mild hybrids for the Proposal or a 66 percent penetration of mild hybrids for Alternative 4. The modeling of both alternatives predicts a 1 to 4 percent penetration of stop/start engine systems.

The table also shows that when strong hybrids are used as a pathway to compliance, penetration rates of all hybrid technologies increase substantially between the proposal and Alternative 4. The analysis predicts an increase in strong hybrid penetration from 8 percent to 12 percent, a 23 percent penetration of mild hybrids and a 10 percent penetration stop/start engine systems for Alternative 4 compared with the proposal. Also, by having the final standards apply in MY2027 instead of MY2025, the proposal is not premised on use of any mild hybrids or stop/start engine systems to achieve the same level of stringency as Alternative 4.

[355] Hybrid batteries, motors and electronics generally add weight to a vehicle and require more space which can result in conflicts with payload weight and volume objectives.

[356] Hybrid electric systems are not sized for situations when vehicles are required to do trailer towing where the combined weight of vehicle and trailer is 2 to 4 times that of the vehicle alone. During these conditions, the hybrid system will have reduced effectiveness. Sizing the system for trailer towing is prohibitive with respect to hybrid component required sizes and the availability of locations to place larger components like batteries.

TABLE VI–9—CAFE MODEL TECHNOLOGY ADOPTION RATES FOR PROPOSAL AND ALTERNATIVE 4 COMBINED FLEET AND FUELS SUMMARY—FLAT BASELINE

Technology	Proposal (2.5% per year) 2021 to 2027		Alternative 4 (3.5% per year) 2021 to 2025	
	With strong hybrids (%)	Without strong hybrids (%)	With strong hybrids (%)	Without strong hybrids (%)
Low friction lubricants	100	100	100	100
Engine friction reduction	100	100	100	100
Cylinder deactivation	21	22	21	14
Variable valve timing	46	46	46	46
Gasoline direct injection	25	45	31	45
Diesel engine improvements	38	38	38	38
Turbo downsized engine [a]	25	31	25	31
8 speed transmission	96	96	96	96
Low rolling resistance tires	97	97	84	84
Aerodynamic drag reduction	100	100	100	100
Mass reduction and materials	100	100	100	100
Electric power steering	80	92	79	79
Improved accessories	67	77	75	75
Low drag brakes	78	93	78	78
Stop/start engine systems	0	1	10	4
Mild hybrid	0	20	23	66
Strong hybrid	8	0	12	0

Note:
[a] The 6+ liter V8 vans were allowed to convert to turbocharged and downsized engines in the "without strong hybrid" analysis for both the Proposal and the Alternative 4 to provide a compliance path.

Table VI–10 and Table VI–11 below provide a further breakdown of projected technology adoption rates specifically for gasoline-fueled pickups and vans which shows potential adoption rates of strong hybrids for each vehicle type. Strong hybrids are not projected to be used in diesel applications. The Alternative 4 analysis shows the use of strong hybrids in up to 48 percent of gasoline pickups, depending on the mix of strong and mild hybrids, and stop/start engine systems in 20 percent of gasoline pickups (the largest gasoline HD segment). It is important to note that this analysis only shows one pathway to compliance, and the manufacturers may make other decisions, *e.g.,* changing the mix of strong vs. mild hybrids, or applying electrification technologies to HD vans instead. The technology adoption rates projected for gasoline pickups and gasoline vans due to the proposed Alternative 3 and Alternative 4 are shown in Table VI–10 and Table VI–11, respectively.

TABLE VI–10—CAFE MODEL TECHNOLOGY ADOPTION RATES FOR PROPOSAL AND ALTERNATIVE 4 ON GASOLINE PICKUP TRUCKS—FLAT BASELINE

Technology	Proposal (2.5% per year) 2021 to 2027		Alternative 4 (3.5% per year) 2021 to 2025	
	With strong hybrids (%)	Without strong hybrids (%)	With strong hybrids (%)	Without strong hybrids (%)
Low friction lubricants	100	100	100	100
Engine friction reduction	100	100	100	100
Cylinder deactivation	56	56	56	56
Variable valve timing	56	56	56	56
Gasoline direct injection	0	56	0	56
8 speed transmission	100	100	100	100
Low rolling resistance tires	100	100	100	100
Aerodynamic drag reduction	100	100	100	100
Mass reduction and materials	100	100	100	100
Electric power steering	100	100	100	100
Improved accessories	100	100	100	100
Low drag brakes	100	100	100	100
Driveline friction reduction	44	68	68	68
Stop/start engine systems	0	0	20	0
Mild hybrid	Up to 42 [a]	0%	18–86 [a]	86
Strong hybrid	Up to 25		Up to 48	

Note:
[a] Depending on extent of strong hybrid adoption as hybrid technologies can replace each other, however they will have different effectiveness and costs.

TABLE VI–11—CAFE MODEL TECHNOLOGY ADOPTION RATES FOR PROPOSAL AND ALTERNATIVE 4 ON GASOLINE VANS—FLAT BASELINE

Technology	Proposal (2.5% per year) 2021 to 2027		Alternative 4 (3.5% per year) 2021 to 2025	
	With strong hybrids (%)	Without strong hybrids (%)	With strong hybrids (%)	Without strong hybrids (%)
Low friction lubricants	100	100	100	100
Engine friction reduction	100	100	100	100
Cylinder deactivation	23	3	23	3
Variable valve timing	100	100	100	100
Gasoline direct injection	57	97	97	97
Turbo downsized engine [a]	77	97	77	97
8 speed transmission	97	97	97	97
Low rolling resistance tires	100	100	60	60
Aerodynamic drag reduction	100	100	100	100
Mass reduction and materials	100	100	100	100
Electric power steering	55	85	53	53
Improved accessories	23	38	43	43
Low drag brakes	53	89	53	100
Stop/start engine systems	0	0	2	0
Mild hybrid	Up to 13 [b]	13	18	40
Strong hybrid	Up to 7		0	

Notes:

[a] The 6+ liter V8 vans were allowed to convert to turbocharged and downsized engines in the "without strong hybrid" analysis for both the Proposal and the Alternative 4 to provide a compliance path.

[b] Depending on extent of strong hybrid adoption as hybrid technologies can replace each other, however they will have different effectiveness and costs.

The tables above show that many technologies would be at or potentially approach 100 percent adoption rates according to the analysis. If certain technologies turn out to be not well suited for certain vehicle models or less effective that projected, other technology pathways would be needed. The additional lead time provided by the proposed Alternative 3 reduces these concerns because manufacturers would have more flexibility to implement their compliance strategy and are more likely to contain a product redesign cycle necessary for many new technologies to be implemented.

GM may have a particular challenge meeting new standards compared to other manufacturers because their production consists of a larger portion of gasoline-powered vehicles and because they continue to offer a traditional style HD van equipped only with a V–8 engine. Under the strong hybrid analysis for Alternative 3, GM is projected to apply strong hybrids to 46 percent of their HD gasoline pickups and 17 percent their HD gasoline vans. Under Alternative 4, GM is projected to apply a combination of 53 percent strong and 43 percent mild hybrids to their HD gasoline pickups and 44 percent mild hybrids to their HD vans. The no strong hybrid analysis shows that GM could comply without strong hybrids based on the use of turbo downsizing on all of their HD gasoline vans to fully comply with either Alternative 3 or Alternative 4. As modeled, Alternative 4 would also require GM to additionally utilize several other technologies such as higher penetration of mild hybridization. If GM were to choose to maintain a V–8 version of their current HD van and not fully utilize turbo downsizing, another compliance path such as some use of strong hybrids would be needed. This would also be the case if GM chose not to fully utilize some other technologies under Alterative 4 as well.

In addition to the possibility of an increased level of hybridization, the agencies are also requesting comment on other possible outcomes associated especially with Alternative 4; in particular, the possibility of traditional van designs or other products being discontinued. Several manufacturers now offer or are moving to European style HD vans. Ford, for example, has discontinued its E-series body on frame HD van and has replaced it with the unibody Transit van for MY 2015. While other manufacturers have replaced their traditional style vans with new European style van designs, GM continues to offer the traditional full frame style van with eight cylinder gasoline engines for higher towing capability (up to 16,000 lb GCWR). Typically, the European style vans are equipped with smaller engines offering better fuel consumption and lower CO_2 emissions but with reduced towing capability, similar to light-duty trucks (though Ford offers a Transit van with a GCWR of 15,000 lb).

The agencies request comment on the potential for Alternative 4 in particular to incentivize GM to discontinue its current traditional style van and replace it with an as yet to be designed European style van similar to its competitor's products. See *Bluewater Network* v. *EPA,* 370 F. 3d 1, 22 (D.C. Cir. 2004) (standard implementing technology-forcing provision of CAA remanded to EPA for an explanation of why the standard was not based on discontinuation of a particular model); *International Harvester* v. *Ruckelshaus,* 478 F. 2d 615, 640–41 (D.C. Cir. 1973) ("We are inclined to agree with the Administrator that as long as feasible technology permits the demand for new passenger automobiles to be generally met, the basic requirements of the Act would be satisfied, even though this might occasion fewer models and a more limited choice of engine types"). Such an outcome could limit consumer choice both on the style of van available in the marketplace and on the range of capabilities of the vehicles available. The agencies have not attempted to cost out this possible compliance path. The agencies request comments on the likelihood of this type of redesign as a possible outcome of Alternative 3 and Alternative 4, and whether it would be appropriate. We are especially interested in comments on the potential impact on consumer choice and the costs associated with this type of wholesale vehicle model replacement.

In addition, another potential outcome of Alternative 4 would be that manufacturers could change the product utility. For example, although GM's traditional van discussed above currently offers similar towing capacity as gasoline pickups, GM could choose to replace engines designed for those towing capacities with small gas or diesel engines. The agencies request comment on the potential for Alternative 4 to lead to this type of compliance approach.

The agencies also request comment on the possibility that Alternative 4 could lead to increased dieselization of the HD pickup and van fleet. Dieselization is not a technology path the agencies included in the analysis for the Phase 1 rule or the Phase 2 proposal but it is something the agencies could consider as a technology path under Alternative 4. As discussed earlier, diesel engines are fundamentally more efficient than gasoline engines providing the same power (even gasoline engines with the technologies discussed above). Alternative 4 could result in manufacturers switching from gasoline engines to diesel engines in certain challenging segments. However, while technologically feasible, this pathway could cause a distortion in consumer choices and significantly increase the cost of those vehicles, particularly considering Alternative 4 is projected to require penetration of some form of hybridization. Also, if dieselization occurs by manufacturers equipping vehicles with larger diesel engines rather than ''right-sized'' engines, the towing capability of the vehicles could increase resulting in higher work factors for the vehicles, higher targets, and reduced program benefits. The issue of surplus towing capability is also discussed above in VI.B. (1).

The technologies associated with meeting the proposed standards are estimated to add costs to heavy-duty pickups and vans as shown in Table VI–12 and Table VI–13 for the flat baseline and dynamic baseline, respectively. These costs are the average fleet-wide incremental vehicle costs relative to a vehicle meeting the MY2018 standard in each of the model years shown. Reductions associated with these costs and technologies are considerable, estimated at a 13.6 percent reduction of fuel consumption and CO_2eq emissions from the MY 2018 baseline for gasoline and diesel engine equipped vehicles.[357] A detailed cost and cost effectiveness analysis for both the proposed preferred Alternative 3 are provided in Section IX and Chapter 7.1 of the draft RIA. As shown by the analysis, the long-term cost effectiveness of the proposal is similar to that of the Phase 1 HD pickup and van standards and also falls within the range of the cost effectiveness for Phase 2 standards proposed for the other HD sectors.[358] The cost of controls would be fully recovered by the operator due to the associated fuel savings, with a payback period somewhere in the third year of ownership, as shown in Section IX.L of this preamble. Consistent with the agencies' respective statutory authorities under 42 U.S.C. 7521(a) and 49 U.S.C. 32902(k)(2), and based on the agencies' analysis, EPA and NHTSA are proposing Alternative 3. The agencies seek comment on Alternative 4, as we may seek to adopt it in whole or in part in the final rule.

We also show the costs for the potential Alternative 4 standards in Table VI–14 and Table VI–15. As shown, the costs under Alternative 4 would be significantly higher compared to Alternative 3.

TABLE VI–12—HD PICKUPS AND VANS INCREMENTAL TECHNOLOGY COSTS PER VEHICLE PREFERRED ALTERNATIVE VS. FLAT BASELINE

[2012$]

	2021	2022	2023	2024	2025	2026	2027
HD Pickups & Vans	$516	$508	$791	$948	$1,161	$1,224	$1,342

TABLE VI–13—HD PICKUPS AND VANS INCREMENTAL TECHNOLOGY COSTS PER VEHICLE PREFERRED ALTERNATIVE VS. DYNAMIC BASELINE

[2012$]

	2021	2022	2023	2024	2025	2026	2027
HD Pickups & Vans	$493	$485	$766	$896	$1,149	$1,248	$1,366

TABLE VI–14—HD PICKUPS AND VANS INCREMENTAL TECHNOLOGY COSTS PER VEHICLE ALTERNATIVE 4 VS. FLAT BASELINE

[2012$]

	2021	2022	2023	2024	2025	2026	2027
HD Pickups & Vans	$1,050	$1,033	$1,621	$1,734	$1,825	$1,808	$1,841

[357] *See* Table VI–5.

[358] Analysis using the MOVES model indicates that the cost effectiveness of these standards is $95 per ton CO_2 eq removed in MY 2030 (Draft RIA Table 7–31), almost identical to the $90 per ton CO_2 eq removed (MY 2030) which the agencies found to be highly cost effective for these same vehicles in Phase 1. See 76 FR 57228.

TABLE VI–15—HD PICKUPS AND VANS INCREMENTAL TECHNOLOGY COSTS PER VEHICLE ALTERNATIVE 4 VS. DYNAMIC BASELINE

[2012$]

	2021	2022	2023	2024	2025	2026	2027
HD Pickups & Vans	$909	$894	$1,415	$1,532	$1,627	$1,649	$1,684

D. DOT CAFE Model Analysis of the Regulatory Alternatives for HD Pickups and Vans

Considering the establishment of potential HD pickup and van fuel consumption and GHG standards to follow those already in place through model year 2018, the agencies evaluated a range of potential regulatory alternatives. The agencies estimated the extent to which manufacturers might add fuel-saving and CO_2-avoiding technologies under each regulatory alternative, including the no-action alternative described in Section X. of this proposal. For HD pickups and vans both agencies analyzed two no-action alternatives, where one no-action alternative could be described as a ''flat baseline'' and the other as a ''dynamic baseline''. Please refer to Section X. of this proposal for a complete discussion of the assumptions that underlie these baselines. The agencies then estimated the extent to which additional technology that would be implemented to meet each regulatory alternative would incrementally (compared to the no-action alternative) impact costs to manufacturers and vehicle buyers, physical outcomes such as highway travel, fuel consumption, and greenhouse gas emissions, and economic benefits and costs to vehicle owners and society. The remainder of this section and portions of Sections VII through X present the regulatory alternatives the agencies have considered, summarize the agencies' analyses, and explain the agencies' selection of the HD pickup and van preferred alternative defined by today's proposed standards.

The agencies conducted coordinated and complementary analyses by employing both DOT's CAFE model and EPA's MOVES model and other analytical tools to project fuel consumption and GHG emissions impacts resulting from the proposed standards for HD pickups and vans, against both the flat and dynamic baselines. In addition to running the DOT CAFE model to provide per vehicle cost and technology values, NHTSA also used the model to estimate the full range of impacts for pickups and vans, including fuel consumption and GHG emissions, including downstream vehicular emissions as well as emissions from upstream processes related to fuel production, distribution, and delivery. The CAFE model applies fuel properties (density and carbon content) to estimated fuel consumption in order to calculate vehicular CO_2 emissions, applies per-mile emission factors (in this analysis, from MOVES) to estimated VMT in order to calculate vehicular CH_4 and N_2O emissions (as well, as discussed below, of non-GHG pollutants), and applies per-gallon upstream emission factors (in this analysis, from GREET) in order to calculate upstream GHG (and non-GHG) emissions. EPA also ran its MOVES model for all HD categories, namely tractors and trailers, vocational vehicles and HD pickups and vans, to develop a consistent set of fuel consumption and CO_2 reductions for all HD categories. The MOVES runs followed largely the procedures described above, with some differences. MOVES used the same technology application rates and costs that are part of the inputs, and used cost per vehicle outputs of the CAFE model to evaluate the proposed standards for HD pickup trucks and vans. The agencies note that these two independent analyses of aggregate costs and benefits both support the proposed standards.

While both agencies fully analyzed the regulatory alternatives against both baselines, NHTSA considered its primary analysis to be based on the dynamic baseline, where certain cost-effective technologies are assumed to be applied by manufacturers to improve fuel efficiency beyond the Phase 1 requirements in the absence of new Phase 2 standards. On the other hand, EPA considered both baselines and EPA's less dynamic or flat baseline analysis is presented in Sections VII through X of this proposal as well as the draft Regulatory Impact Analysis accompanying this proposal. In Section X both the flat and dynamic baseline analyses are presented for all of the regulatory alternatives.

This section provides a discussion of the CAFE model, followed by the comprehensive results of the CAFE model against the dynamic baseline to show costs, benefits, and environmental impacts of the regulatory alternatives for HD pickups and vans. This presentation of regulatory analysis is consistent with NHTSA's presentation of similar analyses conducted in support of the agencies joint light-duty vehicle fuel economy and GHG regulations. The CAFE analysis against the flat baseline as well as EPA's complementary analysis of GHG impacts, non-GHG impacts, and economic and other impacts using MOVES is presented in Sections VII through IX of this proposal, as well as in the draft Regulatory Impact Analysis accompanying this proposal. These are presented side-by-side with the agencies' joint analyses of the other heavy-duty sectors (*i.e.,* tractors, trailers, vocational vehicles). The presentation of the EPA analyses of HD pickups and vans in these sections is consistent with the agencies' presentation of similar analyses conducted as part of the agencies' joint HD Phase 1 regulations and with EPA's presentation of similar analyses conducted in support of the agencies' joint light-duty vehicle fuel economy and GHG regulations. The agencies' intention for presenting both of these complementary and coordinated analyses is to offer interested readers the opportunity to compare the regulatory alternatives considered for Phase 2 in both the context of our Phase 1 analytical approaches and our light-duty vehicle analytical approaches.

(1) Evaluation of Regulatory Alternatives

As discussed in Section C above, the agencies used DOT's CAFE model to conduct an analysis of potential standards for HD pickups and vans. The basic operation of the CAFE model was described in section VI.C.2, so will not be repeated here. However, this section provides additional detail on the model operation, inputs, assumptions, and outputs.

DOT developed the CAFE model in 2002 to support the 2003 issuance of CAFE standards for MYs 2005–2007 light trucks. DOT has since significantly expanded and refined the model, and has applied the model to support every ensuing CAFE rulemaking;

• 2006: MYs 2008–2011 light trucks

- 2008: MYs 2011–2015 passenger cars and light trucks (final rule prepared but withheld)
- 2009: MY 2011 passenger cars and light trucks
- 2010: MYs 2012–2016 passenger cars and light trucks (joint rulemaking with EPA)
- 2012: MYs 2017–2021 passenger cars and light trucks (joint rulemaking with EPA)

Past analyses conducted using the CAFE model have been subjected to extensive and detailed review and comment, much of which has informed the model's expansion and refinement. NHTSA's use of the model was considered and supported in *Center for Biological Diversity* v. *National Highway Traffic Safety Admin.,* 538 F.3d 1172, 1194 (9th Cir. 2008). For further discussion see 76 FR 57198, and the model has been subjected to formal peer review and review by the General Accounting Office (GAO) and National Research Council (NRC). NHTSA makes public the model, source code, and—except insofar as doing so would compromise confidential business information (CBI) manufacturers have provided to NHTSA—all model inputs and outputs underlying published rulemaking analyses.

This analysis reflects several changes made to the model since 2012, when NHTSA used the model to estimate the effects, costs, and benefits of final CAFE standards for light-duty vehicles produced during MYs 2017–2021, and augural standards for MYs 2022–2025. Some of these changes specifically enable analysis of potential fuel consumption standards (and, hence, related CO_2 emissions standards harmonized with fuel consumption standards) for heavy-duty pickups and vans; other changes implement more general improvements to the model. Key changes include the following:

- Expansion and restructuring of model inputs, compliance calculations, and reporting to accommodate standards for heavy-duty pickups and vans, including attribute-based standards involving targets that vary with ''work factor''.
- Explicit calculation of test weight, taking into account test weight ''bins'' and differences in the definition of test weight for light-duty vehicles (curb weight plus 300 pound) and heavy-duty pickups and vans (average of GVWR and curb weight).
- Procedures to estimate increases in payload when curb weight is reduced, increases in towing capacity if GVWR is reduced, and calculation procedures to correspondingly update calculated work factors.
- Expansion of model inputs, procedures, and outputs to accommodate technologies not included in prior analyses.
- Changes to the algorithm used to apply technologies, enabling more explicit accounting for shared vehicle platforms and adoption and ''inheritance'' of major engine changes.
- Expansion of the Monte Carlo simulation procedures used to perform probabilistic uncertainty analysis.

These changes are reflected in updated model documentation available at NHTSA's Web site, the documentation also providing more information about the model's purpose, scope, structure, design, inputs, operation, and outputs. DOT invites comment on the updated model, and in particular, on the updated handling of shared vehicle platforms, engines, and transmissions, and on the new procedures to estimate changes to test weight, GVWR, and GCWR as vehicle curb weight is reduced.

(a) Product Cadence

Past comments on the CAFE model have stressed the importance of product cadence—*i.e.,* the development and periodic redesign and freshening of vehicles—in terms of involving technical, financial, and other practical constraints on applying new technologies, and DOT has steadily made changes to the model with a view toward accounting for these considerations. For example, early versions of the model added explicit ''carrying forward'' of applied technologies between model years, subsequent versions applied assumptions that most technologies would be applied when vehicles are freshened or redesigned, and more recent versions applied assumptions that manufacturers would sometimes apply technology earlier than ''necessary'' in order to facilitate compliance with standards in ensuing model years. Thus, for example, if a manufacturer is expected to redesign many of its products in model years 2018 and 2023, and the standard's stringency increases significantly in model year 2021, the CAFE model will estimate the potential that the manufacturer will add more technology than necessary for compliance in MY 2018, in order to carry those product changes forward through the next redesign and contribute to compliance with the MY 2021 standard.

The model also accommodates estimates of overall limits (expressed as ''phase-in caps'' in model inputs) on the rates at which manufacturers' may practicably add technology to their respective fleets. So, for example, even if a manufacturer is expected to redesign half of its production in MY 2016, if the manufacturer is not already producing any strong hybrid electric vehicles (SHEVs), a phase-in cap can be specified in order to assume that manufacturer will stop applying SHEVs in MY 2016 once it has done so to at least 3 percent of its production in that model year.

After the light-duty rulemaking analysis accompanying the 2012 final rule regarding post-2016 CAFE standards and related GHG emissions standards, DOT staff began work on CAFE model changes expected to better reflect additional considerations involved with product planning and cadence. These changes, summarized below, interact with preexisting model characteristics discussed above.

(b) Platforms and Technology

The term ''platform'' is used loosely in industry, but generally refers to a common structure shared by a group of vehicle variants. The degree of commonality varies, with some platform variants exhibiting traditional ''badge engineering'' where two products are differentiated by little more than insignias, while other platforms be used to produce a broad suite of vehicles that bear little outer resemblance to one another.

Given the degree of commonality between variants of a single platform, manufacturers do not have complete freedom to apply technology to a vehicle: while some technologies (*e.g.* low rolling resistance tires) are very nearly ''bolt-on'' technologies, others involve substantial changes to the structure and design of the vehicle, and therefore necessarily are constant between vehicles that share a common platform. DOT staff has, therefore, modified the CAFE model such that all mass reduction and aero technologies are forced to be constant between variants of a platform. The agencies request comment on the suitability of this viewpoint, and which technologies can deviate from one platform variant to another.

Within the analysis fleet, each vehicle is associated with a specific platform. As the CAFE model applies technology, it first defines a platform ''leader'' as the vehicle variant of a platform with the highest technology utilization vehicle of mass reduction and aerodynamic technologies. As the vehicle applies technologies, it effectively harmonizes to the highest common denominator of the platform. If there is a tie, the CAFE model begins applying aerodynamic and mass reduction technology to the vehicle with the lowest average sales across all available model years. If there remains a tie, the model begins by choosing the vehicle with the highest average MSRP across all available model years. The model follows this formulation due to previous market trends suggesting that many technologies begin deployment at the high-end, low-volume end of the market as manufacturers build their confidence and capability in a technology, and later expand the technology across more mainstream product lines.

In the HD pickup and van market, there is a relatively small amount of diversity in platforms produced by manufacturers: typically 1–2 truck platforms and 1–2 van platforms. However, accounting for platforms will take on greater significance in future analyses involving the light-duty fleet, and the agency requests comments on the general use of platforms within CAFE rulemaking.

(c) Engine and Transmission Inheritance

In practice, manufacturers are limited in the number of engines and transmissions that they produce. Typically a manufacturer produces a number of engines—perhaps six or eight engines for a large manufacturer—and tunes them for slight variants in output for a variety of car and truck applications. Manufacturers limit complexity in their engine portfolio for much the same reason as they limit complexity in vehicle variants: They face engineering manpower limitations, and supplier, production and service costs that scale with the number of parts produced.

In previous usage of the CAFE model, engines and transmissions in individual models were allowed relative freedom in technology application, potentially leading to solutions that would, if followed, involve unaccounted-for costs associated with increased complexity in the product portfolio. The lack of a constraint in this area allowed the model to apply different levels of technology to the engine in each vehicle at the time of redesign or refresh, independent of what was done to other vehicles using a previously identical engine.

In the current version of the CAFE model, engines and transmissions that are shared between vehicles must apply the same levels of technology in all technologies dictated by engine or transmission inheritance. This forced adoption is referred to as ''engine inheritance'' in the model documentation.

As with platform-shared technologies, the model first chooses an ''engine leader'' among vehicles sharing the same engine. The leader is selected first by the vehicle with the lowest average sales across all available model years. If there is a tie, the vehicle with the highest average MSRP across model years is chosen. The model applies the same logic with respect to the application of transmission changes. As with platforms, this is driven by the concept that vehicle manufacturers typically deploy new technologies in small numbers prior to deploying widely across their product lines.

(d) Interactions Between Regulatory Classes

Like earlier versions, the current CAFE model provides for integrated analysis spanning different regulatory classes, accounting both for standards that apply separately to different classes and for interactions between regulatory classes. Light vehicle CAFE standards are specified separately for passenger cars and light trucks. However, there is considerable sharing between these two regulatory classes. Some specific engines and transmissions are used in both passenger cars and light trucks, and some vehicle platforms span these regulatory classes. For example, some sport-utility vehicles are offered in 2WD versions classified as passenger cars and 4WD versions classified as light trucks. Integrated analysis of manufacturers' passenger car and light truck fleets provides the ability to account for such sharing and reduce the likelihood of finding solutions that could involve impractical levels of complexity in manufacturers' product lines. In addition, integrated analysis provides the ability to simulate the potential that manufactures could earn CAFE credits by over complying with one standard and use those credits toward compliance with the other standard (*i.e.,* to simulate credit transfers between regulatory classes).

HD pickups and vans are regulated separately from light-duty vehicles. While manufacturers cannot transfer credits between light-duty and MDHD classes, there is some sharing of engineering and technology between light-duty vehicles and HD pickups and vans. For example, some passenger vans with GVWR over 8,500 lbs are classified as medium-duty passenger vehicles (MDPVs) and thus included in manufacturers' light-duty truck fleets, while cargo vans sharing the same nameplate are classified as HD vans.

While today's analysis examines the HD pickup and van fleet in isolation, as a basis for analysis supporting the planned final rule, the agencies intend to develop an overall analysis fleet spanning both the light-duty and HD pickup and van fleets. Doing so could show some technology ''spilling over'' to HD pickups and vans due, for example, to the application of technology in response to current light-duty standards. More generally, modeling the two fleets together should tend to more realistically limit the scope and complexity of estimated compliance pathways.

The agencies anticipate that the impact of modeling a combined fleet will primarily arise from engine-transmission inheritance. While platform sharing between the light-duty and MD pickup and van fleets is relatively small (MDPVs aside), there are a number of instances of engine and transmission sharing across the two fleets. When the fleets are modeled together, the agencies anticipate that engine inheritance will be implemented across the combined fleet, and therefore only one engine-transmission leader can be defined across the combined fleet. As with the fleets separately, all vehicles using a shared engine/transmission would automatically adopt technologies adopted by the engine-transmission leader.

The agencies request comment on plans to analyze the light-duty and MD pickup and van fleets jointly in support of planning for the final rule.

(e) Phase-In Caps

The CAFE model retains the ability to use phase-in caps (specified in model inputs) as proxies for a variety of practical restrictions on technology application. Unlike vehicle-specific restrictions related to redesign, refreshes or platforms/engines, phase-in caps constrain technology application at the vehicle manufacturer level. They are intended to reflect a manufacturer's overall resource capacity available for implementing new technologies (such as engineering and development personnel and financial resources), thereby ensuring that resource capacity is accounted for in the modeling process.

In previous CAFE rulemakings, redesign/refresh schedules and phase-in caps were the primary mechanisms to reflect an OEM's limited pool of available resources during the rulemaking time frame and the years leading up to the rulemaking time frame, especially in years where many models may be scheduled for refresh or redesign. The newly-introduced representation platform-, engine-, and transmission-related considerations discussed above augment the model's preexisting representation of redesign cycles and accommodation of phase-in caps. Considering these new constraints, inputs for today's analysis de-emphasize reliance on phase-in caps.

In this application of the CAFE model, phase-in caps are used only for the most advanced technologies included in the analysis, *i.e.,* SHEVs and lean-burn GDI engines, considering that these technologies are most likely to involve implementation costs and risks not otherwise accounted for in corresponding input estimates of technology cost. For these two technologies, the agencies have applied caps that begin at 3 percent (*i.e.,* 3 percent of the manufacturer's production) in MY 2017, increase at 3 percent annually during the ensuing nine years (reaching 30 percent in the MY 2026), and subsequently increasing at 5 percent annually for four years (reaching 50 percent in MY 2030). Note that the agencies did not feel that lean-burn engines were feasible in the timeframe of this rulemaking, so decided to reject any model runs where they were selected. Due to the cost ineffectiveness of this technology, it was never chosen. The agencies request comment on the appropriateness of these phase-in caps as proxies for constraints that, though not monetized by the agencies, nonetheless limit rates at which these two technologies can practicably be deployed, and on the appropriateness of setting inputs to stop applying phase-in caps to other technologies in this analysis. Comments on this issue should provide information supporting any alternative recommended inputs.

(f) Impact of Vehicle Technology Application Requirements

Compared to prior analyses of light-duty standards, these model changes, along with characteristics of the HD pickup and van fleet result in some changes in the broad characteristics of the model's application of technology to manufacturers' fleets. First, since the number of HD pickup and van platforms in a portfolio is typically small, compliance with standards may appear especially ''lumpy'' (compared to previous applications of the CAFE model to the more highly segmented light-duty fleet), with significant over compliance when widespread redesigns precede stringency increases, and/or significant application of carried-forward (aka ''banked'') credits.

Second, since the use of phase-in caps has been de-emphasized and manufacturer technology deployment remains tied strongly to estimated product redesign and freshening schedules, technology penetration rates may jump more quickly as manufacturers apply technology to high-volume products in their portfolio.

By design, restrictions that enforce commonality of mass reduction and aerodynamic technologies on variants of a platform, and those that enforce engine inheritance, will result in fewer vehicle-technology combinations in a manufacturer's future modeled fleet. These restrictions are expected to more accurately capture the true costs associated with producing and maintaining a product portfolio.

(g) Accounting for Test Weight, Payload, and Towing Capacity

As mentioned above, NHTSA has also revised the CAFE model to explicitly account for the regulatory ''binning'' of test weights used to certify light-duty fuel economy and HD pickup and van fuel consumption for purposes of evaluating fleet-level compliance with fuel economy and fuel consumption standards. For HD pickups and vans, test weight (TW) is based on adjusted loaded vehicle weight (ALVW), which is defined as the average of gross vehicle weight rating (GVWR) and curb weight (CW). TW values are then rounded, resulting in TW ''bins'':

ALVW ≤ 4,000 lb.: TW rounded to nearest 125 lb.
4,000 lb. < ALVW ≤ 5,500 lb.: TW rounded to nearest 250 lb.
ALVW > 5,500 lb.: TW rounded to nearest 500 lb.

This ''binning'' of TW is relevant to calculation of fuel consumption reductions accompanying mass reduction. Model inputs for mass reduction (as an applied technology) are expressed in terms of a percentage reduction of curb weight and an accompanying estimate of the percentage reduction in fuel consumption, setting aside rounding of test weight. Therefore, to account for rounding of test weight, NHTSA has modified these calculations as follows:

$$\Delta FC_{rounded\_TW} = \Delta TW \times \frac{\Delta FC_{unrounded\_TW}}{\Delta CW}$$

Where:
ΔCW = % change in curb weight (from model input),
$\Delta FC_{unrounded\_TW}$ = % change in fuel consumption (from model input), without TW rounding,
ΔTW = % change in test weight (calculated), and
$\Delta FC_{rounded\_TW}$ = % change in fuel consumption (calculated), with TW rounding.

As a result, some applications of vehicle mass reduction will produce no compliance benefit at all, in cases where the changes in ALVW are too small to change test weight when rounding is taken into account. On the other hand, some other applications of vehicle mass reduction will produce significantly more compliance benefit than when rounding is not taken into account, in cases where even small changes in ALVW are sufficient to cause vehicles' test weights to increase by, *e.g.,* 500 lbs when rounding is accounted for. Model outputs now include initial and final TW, GVWR, and GCWR (and, as before, CW) for each vehicle model in each model year, and the agencies invite comment on the extent to which these changes to account explicitly for changes in TW are likely to produce more realistic estimates of the compliance impacts of reductions in vehicle mass.

In addition, considering that the regulatory alternatives in the agencies' analysis all involve attribute-based standards in which underlying fuel consumption targets vary with ''work factor'' (defined by the agencies as the sum of three quarters of payload, one quarter of towing capacity, and 500 lb. for vehicles with 4WD), NHTSA has modified the CAFE model to apply inputs defining shares of curb weight reduction to be ''returned'' to payload and shares of GVWR reduction to be returned to towing capacity. The standards' dependence on work factor provides some incentive to increase payload and towing capacity, both of which are buyer-facing measures of vehicle utility. In the agencies' judgment, this provides reason to assume that if vehicle mass is reduced, manufacturers are likely to ''return'' some of the change to payload and/or towing capacity. For this analysis, the agencies have applied the following assumptions:

- GVWR will be reduced by half the amount by which curb weight is reduced. In other words, 50 percent of the curb weight reduction will be returned to payload.

• GCWR will not be reduced. In other words, 100 percent of any GVWR reduction will be returned to towing capacity.

• GVWR/CW and GCWR/GVWR will not increase beyond levels observed among the majority of similar vehicles (or, for outlier vehicles, initial values):

TABLE VI–16—RATIOS FOR MODIFYING GVW AND GCW AS A FUNCTION OF MASS REDUCTION

Group	Maximum ratios assumed enabled by mass reduction	
	GVWR/CW	GCWR/GVWR
Unibody	1.75	1.50
Gasoline pickups >13k GVWR	2.00	1.50
Other gasoline pickups	1.75	2.25
Diesel SRW pickups	1.75	2.50
All other	1.75	2.25

The first of two of these inputs are specified along with standards for each regulatory alternative, and the GVWR/CW and GCWR/GVWR ''caps'' are specified separately for each vehicle model in the analysis fleet.

In addition, DOT has changed the model to prevent HD pickup and van GVWR from falling below 8,500 lbs when mass reduction is applied (because doing so would cause vehicles to be reclassified as light-duty vehicles), and to treat any additional mass for hybrid electric vehicles as *reducing* payload by the same amount (*e.g.,* if adding a strong HEV package to a vehicle involves a 350 pound penalty, GVWR is assumed to remain unchanged, such that payload is also reduced by 350 lbs).

The agencies invite comment on these methods for estimating how changes in vehicle mass may impact fuel consumption, GVWR, and GCWR, and on corresponding inputs to today's analysis.

(2) Development of the Analysis Fleet

As discussed above, both agencies used DOT's CAFE modeling system to estimate technology costs and application rates under each regulatory alternative, including the no action alternative (which reflects continuation of previously-promulgated standards). Impacts under each of the ''action'' alternatives are calculated on an incremental basis relative to impacts under the no action alternative. The modeling system relies on many inputs, including an analysis fleet. In order to estimate the impacts of potential standards, it is necessary to estimate the composition of the future vehicle fleet. Doing so enables estimation of the extent to which each manufacturer may need to add technology in response to a given series of attribute-based standards, accounting for the mix and fuel consumption of vehicles in each manufacturer's regulated fleet. The agencies create an analysis fleet in order to track the volumes and types of fuel economy-improving and CO_2-reducing technologies that are already present in the existing vehicle fleet. This aspect of the analysis fleet helps to keep the CAFE model from adding technologies to vehicles that already have these technologies, which would result in ''double counting'' of technologies' costs and benefits. An additional step involved projecting the fleet sales into MYs 2019–2030. This represents the fleet volumes that the agencies believe would exist in MYs 2019–2030. The following presents an overview of the information and methods applied to develop the analysis fleet, and some basic characteristics of that fleet.

The resultant analysis fleet is provided in detail at NHTSA's Web site, along with all other inputs to and outputs from today's analysis. The agencies invite comment on this analysis fleet and, in particular, on any other information that should be reflected in an analysis fleet used to update the agencies' analysis for the final rule. Also, the agencies also invites comment on the potential expansion of this analysis fleet such that the impacts of new HD pickup and van standards can be estimated within the context of an integrated analysis of light-duty vehicles and HD pickups and vans, accounting for interactions between the fleets.

(a) Data Sources

Most of the information about the vehicles that make up the 2014 analysis fleet was gathered from the 2014 Pre-Model Year Reports submitted to EPA by the manufacturers under Phase 1 of Fuel Efficiency and GHG Emission Program for Medium- and Heavy-Duty Trucks, MYs 2014–2018.

The major manufacturers of class 2b and class 3 trucks (Chrysler, Ford and GM) were asked to voluntarily submit updates to their Pre-Model Year Reports. Updated data were provided by Chrysler and GM. These updated data were used in constructing the analysis fleet for these manufacturers.

The agencies agreed to treat this information as Confidential Business Information (CBI) until the publication of the proposed rule. This information can be made public at this time because by now all MY2014 vehicle models have been produced, which makes data about them essentially public information.

These data (by individual vehicle configuration produced in MY2014) include: Projected Production Volume/MY2014 Sales, Drive Type, Axle Ratio, Work Factor, Curb Weight, Test Weight,[359] GVWR, GCWR, Fuel Consumption (gal/100 mile), engine type (gasoline or diesel), engine displacement, transmission type and number of gears.

The column ''Engine'' of the Pre-Model Year report for each OEM was copied to the column ''Engine Code'' of the vehicle sheet of the CAFE model market data input file. Values of ''Engine'' were changed to Engine Codes for use in the CAFE model. The codes indicated on the vehicle sheet map the detailed engine data on the engine sheet to the appropriate vehicle on the vehicle sheet of the CAFE model input file.

The column ''Trans Class'' of the Pre-Model Year report for each OEM was copied to the column ''Transmission Code'' of the vehicle sheet of the market data input file. Values of ''Trans Class'' were changed to Transmission Codes for use in the CAFE model. The codes indicated on the vehicle sheet map the detailed transmission data on the transmission sheet to the appropriate vehicle on the vehicle sheet of the CAFE model input file.

In addition to information about each vehicle, the agencies need additional

[359] Chrysler and GM did not provide test weights in their submittals. Test weights were calculated as the average of GVWR and curb weight rounded up to the nearest 100 lb.

information about the fuel economy-improving/CO_2-reducing technologies already on those vehicles in order to assess how much and which technologies to apply to determine a path toward future compliance. Thus, the agencies augmented this information with publicly-available data that includes more complete technology descriptions. Specific engines and transmissions associated with each manufacturer's trucks were identified using their respective internet sites. Detailed technical data on individual engines and transmissions indicated on the engine sheet and transmission sheet of the CAFE model input file were then obtained from manufacturer internet sites, spec sheets and product literature, Ward's Automotive Group and other commercial internet sites such as cars.com, edmunds.com, and motortrend.com. Specific additional information included:

- ''Fuel Economy on Secondary Fuel'' was calculated as E85 = .74 gasoline fuel economy, or B20 = .98 diesel fuel economy. These values were duplicated in the columns ''Fuel Economy (Ethanol-85)'' and ''Fuel Economy (Biodiesel-20)'' of the CAFE market data input file.
- Values in the columns ''Fuel Share (Gasoline)'', ''Fuel Share (Ethanol-85)'', ''Fuel Share (Diesel),'' and ''Fuel Share (Biodiesel-20)'' are Volpe assumptions.
- The CAFE model also requires that values of Origin, Regulatory Class, Technology Class, Safety Class, and Seating (Max) be present in the file in order for the model to run. Placeholder values were added in these columns.
- In addition to the data taken from the OEM Pre Model Year submittals, NHTSA added additional data for use by the CAFE model. These included Platform, Refresh Years, Redesign Years, MSRP, Style, Structure and Fuel Capacity.
- MSRP was obtained from web2carz.com and the OEM Web sites.
- Fuel capacity was obtained from OEM spec sheets and product literature.
- The Structure values (Ladder, Unibody) used by the CAFE model were added. These were determined from OEM product literature and the automotive press. It should be noted that the new vans such as the Transit in fact utilize a ladder/unibody structure. Ford product literature uses the term ''Uniladder'' to describe the structure. Vans based on this structure are noted in the Vehicle Notes column of the NHTSA input file.
- Style values used by the CAFE model were also added: Chassis Cab, Cutaway, Pickup and Van.

(b) Vehicle Redesign Schedules and Platforms

Product cadence in the Class 2b and 3 pickup market has historically ranged from 7–9 years between major redesigns. However, due to increasing competitive pressures and consumer demands the agency anticipates that manufacturers will generally shift to shorter design cycles resembling those of the light duty market. Pickup truck manufacturers in the Class 2b and 3 segments are shown to adopt redesign cycles of six years, allowing two redesigns prior to the end of the regulatory period in 2025. The agencies request comment on the anticipated future use of redesign cycles in this product segment.

The Class 2b and 3 van market has changed markedly from five years ago. Ford, Nissan, Ram and Daimler have adopted vans of ''Euro Van'' appearance, and in many cases now use smaller turbocharged gasoline or diesel engines in the place of larger, naturally-aspirated V8s. The 2014 Model Year used in this analysis represents a period where most manufacturers, with the exception of General Motors, have recently introduced a completely redesigned product after many years. The van segment has historically been one of the slowest to be redesigned of any product segment, with some products going two decades or more between redesigns.

Due to new entrants in the field and increased competition, the agencies anticipate that most manufacturers will increase the pace of product redesigns in the van segment, but that they will continue to trail other segments. The cycle time used in this analysis is approximately ten years between major redesigns, allowing manufacturers only one major redesign during the regulatory period. The agencies request comment on this anticipated product design cycle.

Additional detail on product cadence assumptions for specific manufacturers is located in Chapter 10 of the draft RIA.

(c) Sales Volume Forecast

Since each manufacturer's required average fuel consumption and GHG levels are sales-weighted averages of the fuel economy/GHG targets across all model offerings, sales volumes play a critical role in estimating that burden. The CAFE model requires a forecast of sales volumes, at the vehicle model-variant level, in order to simulate the technology application necessary for a manufacturer to achieve compliance in each model year for which outcomes are simulated.

For today's analysis, the agencies relied on the MY 2014 pre-model-year compliance submissions from manufacturers to provide sales volumes at the model level based on the level of disaggregation in which the models appear in the compliance data. However, the agencies only use these reported volumes without adjustment for MY 2014. For all future model years, we combine the manufacturer submissions with sales projections from the 2014 Annual Energy Outlook Reference Case and IHS Automotive to determine model variant level sales volumes in future years.[360] The projected sales volumes by class that appear in the 2014 Annual Energy Outlook as a result of a collection of assumptions about economic conditions, demand for commercial miles traveled, and technology migration from light-duty pickup trucks in response to the concurrent light-duty CAFE/GHG standards. These are shown in Chapter 2 of the draft RIA.

For this analysis, the agencies have limited this analysis fleet to class 2b and 3 HD pickups and vans. However, especially considering interactions between the light-duty and HD pickup and van fleets (*e.g.,* MDPVs being included in the light-duty fleet), the agencies are evaluating the potential to analyze the fleets in an integrated fashion for the final rule, and invite comment on the extent to which doing so could provide more realistic estimates of the incremental impacts of new standards applicable HD pickups and vans.

The projection of total sales volumes for the Class 2b and 3 market segment was based on the total volumes in the 2014 AEO Reference Case. For the purposes of this analysis, the AEO2014 calendar year volumes have been used to represent the corresponding model-year volumes. While AEO2014 provides enough resolution in its projections to separate the volumes for the Class 2b and 3 segments, the agencies deferred to the vehicle manufacturers and chose to rely on the relative shares present in the pre-model-year compliance data.

The relative sales share by vehicle type (van or pickup truck, in this case) was derived from a sales forecast that the agencies purchased from IHS Automotive, and applied to the total volumes in the AEO2014 projection. Table VI–17 shows the implied shares of the total new 2b/3 vehicle market broken down by manufacturer and vehicle type.

[360] Tables from AEO's forecast are available at *http://www.eia.gov/oiaf/aeo/tablebrowser/.* The agencies also made use of the IHS Automotive Light Vehicle Production Forecast (August 2014).

TABLE VI–17—IHS AUTOMOTIVE MARKET SHARE FORECAST FOR 2b/3 VEHICLES

Manufacturer	Style	Model year market share						
		2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)
Daimler	Van	3	3	3	3	3	3	3
Fiat	Van	2	2	2	2	2	2	3
Ford	Van	16	17	17	17	18	18	18
General Motors	Van	12	12	11	12	13	13	13
Nissan	Van	2	2	2	2	2	2	2
Daimler	Pickup	0	0	0	0	0	0	0
Fiat	Pickup	14	14	14	14	11	12	12
Ford	Pickup	28	27	30	30	30	27	26
General Motors	Pickup	23	23	21	21	21	22	23
Nissan	Pickup	0	0	0	0	0	0	0

Within those broadly defined market shares, volumes at the manufacturer/model-variant level were constructed by applying the model-variant's share of manufacturer sales in the pre-model-year compliance data for the relevant vehicle style, and multiplied by the total volume estimated for that manufacturer and that style.

After building out a set of initial future sales volumes based on the sources described above, the agencies attempted to incorporate new information about changes in sales mix that would not be captured by either the existing sales forecasts or the simulated technology changes in vehicle platforms. In particular, Ford has announced intentions to phase out their existing Econoline vans, gradually shifting volumes to the new Transit platform for some model variants (notably chassis cabs and cutaways variants) and eliminating offerings outright for complete Econoline vans as early as model year 2015. In the case of complete Econoline vans, the volumes for those vehicles were allocated to MY2015 Transit vehicles based on assumptions about likely production splits for the powertrains of the new Transit platform. The volumes for complete Econoline vans were shifted at ratios of 50 percent, 35 percent, and 15 percent for 3.7 L, 3.5 L Eco-boost, and 3.2 L diesel, respectively. Within each powertrain, sales were allocated based on the percentage shares present in the pre-model-year compliance data. The chassis cab and cutaway variants of the Econolines were phased out linearly between MY2015 and MY2020, at which time the Econolines cease to exist in any form and all corresponding volume resides with the Transits.

(3) Additional Technology Cost and Effectiveness Inputs

In addition to the base technology cost and effectiveness inputs described in VI. of this preamble, the CAFE model has some additional cost and effectiveness inputs, described as follows.

The CAFE model accommodates inputs to adjust accumulated effectiveness under circumstances when combining multiple technologies could result in underestimation or overestimation of total incremental effectiveness relative to an ''unevolved'' baseline vehicle. These so-called synergy factors may be positive, where the combination of the technologies results in greater improvement than the additive improvement of each technology, or negative, where the combination of the technologies is lower than the additive improvement of each technology. The synergy factors used in this analysis are described in VI–18.

TABLE VI–18—TECHNOLOGY PAIR EFFECTIVENESS SYNERGY FACTORS FOR HD PICKUPS AND VANS

Technology pair	Adjustment (%)	Technology pair	Adjustment (%)
8SPD/CCPS	−4.60	IATC/CCPS	−1.30
8SPD/DEACO	−4.60	IATC/DEACO	−1.30
8SPD/ICP	−4.60	IATC/ICP	−1.30
8SPD/TRBDS1	4.60	IATC/TRBDS1	1.30
AERO2/SHEV1	1.40	MR1/CCPS	0.40
CCPS/IACC1	−0.40	MR1/DCP	0.40
CCPS/IACC2	−0.60	MR1/VVA	0.40
DCP/IACC1	−0.40	MR2/ROLL1	−0.10
DCP/IACC2	−0.60	MR2/SHEV1	−0.40
DEACD/IATC	−0.10	NAUTO/CCPS	−1.70
DEACO/IACC2	−0.80	NAUTO/DEACO	−1.70
DEACO/MHEV	−0.70	NAUTO/ICP	−1.70
DEACS/IATC	−0.10	NAUTO/SAX	−0.40
DTURB/IATC	1.00	NAUTO/TRBDS1	1.70
DTURB/MHEV	−0.60	ROLL1/AERO1	0.10
DTURB/SHEV1	−1.00	ROLL1/SHEV1	1.10
DVVLD/8SPD	−0.60	ROLL2/AERO2	0.20
DVVLD/IACC2	−0.80	SHFTOPT/MHEV	−0.30
DVVLD/IATC	−0.60	TRBDS1/MHEV	0.80
DVVLD/MHEV	−0.70	TRBDS1/SHEV1	−3.30
DVVLS/8SPD	−0.60	TRBDS1/VVA	−8.00
DVVLS/IACC2	−0.80	TRBDS2/EPS	−0.30
DVVLS/IATC	−0.50	TRBDS2/IACC2	−0.30
DVVLS/MHEV	−0.70	TRBDS2/NAUTO	−0.50
		VVA/IACC1	−0.40
		VVA/IACC2	−0.60
		VVA/IATC	−0.60

The CAFE model also accommodates inputs to adjust accumulated incremental costs under circumstances when the application sequence could result in underestimation or overestimation of total incremental costs relative to an ''unevolved'' baseline vehicle. For today's analysis, the agencies have applied one such adjustment, increasing the cost of medium-sized gasoline engines by $513 in cases where turbocharging and engine downsizing is applied with variable valve actuation.

The analysis performed using Method A also applied cost inputs to address some costs encompassed neither by the agencies' estimates of the direct cost to apply these technologies, nor by the agencies' methods for ''marking up'' these costs to arrive at increases in the new vehicle purchase costs. To account for the additional costs that could be incurred if a technology is applied and then quickly replaced, the CAFE model accommodates inputs specifying a ''stranded capital cost'' specific to each technology. For this analysis, the model was run with inputs to apply about $78 of additional cost (per engine) if gasoline engine turbocharging and downsizing (separately for each ''level'' considered) is applied and then immediately replaced, declining steadily to zero by the tenth model year following initial application of the technology. The model also accommodates inputs specifying any additional changes owners might incur in maintenance and post-warranty repair costs. For this analysis, the model was run with inputs indicating that vehicles equipped with less rolling-resistant tires could incur additional tire replacement costs equivalent to $21–$23 (depending on model year) in additional costs to purchase the new vehicle. The agencies did not, however, include inputs specifying any potential changes repair costs that might accompany application of any of the above technologies. A sensitivity analysis using Method A, discussed below, includes a case in which repair costs are estimated using factors consistent with those underlying the indirect cost multipliers used to mark up direct costs for the agencies' central analysis.

The agencies invite comment on all efficacy and cost inputs involved in today's analysis and request that commenters provide any additional data or forward-looking estimates that could be used to support alternative inputs, including those related to costs beyond those reflected in the cost to purchase new vehicles.

(4) Other Analysis Inputs

In addition to the inputs summarized above, the analysis of potential standards for HD pickups and vans makes use of a range of other estimates and assumptions specified as inputs to the CAFE modeling system. Some significant inputs (*e.g.,* estimates of future fuel prices) also applicable to other MDHD segments are discussed below in Section IX. Others more specific to the analysis of HD pickups and vans are as follows:

(a) Vehicle Survival and Mileage Accumulation:

Today's analysis estimates the travel, fuel consumption, and emissions over the useful lives of vehicles produced during model years 2014–2030. Doing so requires initial estimates of these vehicles' survival rates (*i.e.,* shares expected to remain in service) and mileage accumulation rates (*i.e.,* anticipated annual travel by vehicles remaining in service), both as a function of vehicle vintage (*i.e.,* age). These estimates are based on an empirical analysis of changes in the fleet of registered vehicles over time, in the case of survival rates, and usage data collected as part of the last Vehicle In Use Survey (the 2002 VIUS), in the case of mileage accumulation.

(b) Rebound Effect

Expressed as an elasticity of mileage accumulation with respect to the fuel cost per mile of operation, the agencies have applied a rebound effect of 10 percent for today's analysis.

(c) On-Road ''Gap''

The model was run with a 20 percent adjustment to reflect differences between on-road and laboratory performance.

(d) Fleet Population Profile

Though not reported here, cumulative fuel consumption and CO_2 emissions are presented in the accompanying draft EIS, and these calculations utilize estimates of the numbers of vehicles produced in each model year remaining in service in calendar year 2014. The initial age distribution of the registered vehicle population in 2014 is based on vehicle registration data acquired by NHTSA from R.L. Polk Company.

(e) Past Fuel Consumption Levels

Though not reported here, cumulative fuel consumption and CO_2 emissions are presented in the accompanying draft EIS, and these calculations require estimates of the performance of vehicles produced prior to model year 2014. Consistent with AEO 2014, the model was run with the assumption that gasoline and diesel HD pickups and vans averaged 14.9 mpg and 18.6 mpg, respectively, with gasoline versions averaging about 48 percent of production.

(f) Long-Term Fuel Consumption Levels

Though not reported here, longer-term estimates of fuel consumption and emissions are presented in the accompanying draft EIS. These estimates include calculations involving vehicle produced after MY 2030 and, consistent with AEO 2014, the model was run with the assumption that fuel consumption and CO_2 emission levels will continue to decline at 0.05 percent annually (compounded) after MY 2030.

(g) Payback Period

To estimate in what sequence and to what degree manufacturers might add fuel-saving technologies to their respective fleets, the CAFE model iteratively ranks remaining opportunities (*i.e.,* applications of specific technologies to specific vehicles) in terms of effective cost, primary components of which are the technology cost and the avoided fuel outlays, attempting to minimize effective costs incurred.[361] Depending on inputs, the model also assumes manufacturers may improve fuel consumption beyond requirements insofar as doing so will involve applications of technology at negative effective cost—*i.e.,* technology application for which buyers' up-front costs are quickly paid back through avoided fuel outlays. This calculation includes only fuel outlays occurring within a specified payback period. For this analysis, a payback period of 6 months was applied for the dynamic baseline case, or Alternative 1b. Thus, for example, a manufacturer already in compliance with standards is projected to apply a fuel consumption improvement projected to cost $250 (*i.e.,* as a cost that could be charged to the buyer at normal profit to the manufacturer) and reduce fuel costs by $500 in the first year of vehicle operation. The agencies have conducted the same analysis applying a payback period of 0 months for the flat baseline case, or Alternative 1a.

(h) Civil Penalties

EPCA and EISA require that a manufacturer pay civil penalties if it does not have enough credits to cover a shortfall with one or both of the light-duty CAFE standards in a model year. While these provisions do not apply to HD pickups and vans, at this time, the CAFE model will show civil penalties owed in cases where available technologies and credits are estimated to be insufficient for a manufacturer to achieve compliance with a standard. These model-reported estimates have been excluded from this analysis.

(i) Coefficients for Fatality Calculations

Today's analysis considered the potential effects on crash safety of the technologies manufacturers may apply to their vehicles to meet each of the regulatory alternatives. NHTSA research has shown that vehicle mass reduction affects overall societal fatalities associated with crashes[362] and, most relevant to this proposal, mass reduction in heavier light- and medium-duty vehicles has an overall beneficial effect on societal fatalities. Reducing the mass of a heavier vehicle involved in a crash with another vehicle(s) makes it less likely there will be fatalities among the occupants of the other vehicles. In addition to the effects of mass reduction, the analysis anticipates that

[361] Volpe CAFE Model, available at *http://www.nhtsa.gov/fuel-economy.*

[362] U.S. DOT/NHTSA, *Relationships Between Fatality Risk Mass and Footprint in MY 2000–2007 PC and LTVs,* ID: NHTSA–2010–0131–0336, Posted August 21, 2012.

the proposed standards, by reducing the cost of driving HD pickups and vans, would lead to increased travel by these vehicles and, therefore, more crashes involving these vehicles. The Method A analysis considers overall impacts considering both of these factors, using a methodology similar to NHTSA's analyses for the MYs 2017—2025 CAFE and GHG emission standards.

The Method A analysis includes estimates of the extent to which HD pickups and vans produced during MYs 2014–2030 may be involved in fatal crashes, considering the mass, survival, and mileage accumulation of these vehicles, taking into account changes in mass and mileage accumulation under each regulatory alternative. These calculations make use of the same coefficients applied to light trucks in the MYs 2017–2025 CAFE rulemaking analysis. Baseline rates of involvement in fatal crashes are 13.03 and 13.24 fatalities per billion miles for vehicles with initial curb weights above and below 4,594 lbs, respectively. Considering that the data underlying the corresponding statistical analysis included observations through calendar year 2010, these rates are reduced by 9.6 percent to account for subsequent impacts of recent Federal Motor Vehicle Safety Standards (FMVSS) and anticipated behavioral changes (*e.g.,* continued increases in seat belt use). For vehicles above 4,594 lbs—*i.e.,* the majority of the HD pickup and van fleet—mass reduction is estimated to reduce the net incidence of highway fatalities by 0.34 percent per 100 lbs of removed curb weight. For the few HD pickups and vans below 4,594 lbs, mass reduction is estimated to increase the net incidence of highway fatalities by 0.52 percent per 100 lbs. Consistent with DOT guidance, the social cost of highway fatalities is estimated using a value of statistical life (VSL) of $9.36m in 2014, increasing thereafter at 1.18 percent annually.

(j) Compliance Credit Provisions

Today's analysis accounts for the potential to over comply with standards and thereby earn compliance credits, applying these credits to ensuring compliance requirements. In doing so, the agencies treat any unused carried-forward credits as expiring after five model years, consistent with current and proposed standards. For today's analysis, the agencies are not estimating the potential to ''borrow''—*i.e.,* to carry credits back to past model years.

(k) Emission Factors

While CAFE model calculates vehicular CO_2 emissions directly on a per-gallon basis using fuel consumption and fuel properties (density and carbon content), the model calculates emissions of other pollutants (methane, nitrogen oxides, ozone precursors, carbon monoxide, sulfur dioxide, particulate matter, and air toxics) on a per-mile basis. In doing so, the Method A analysis used corresponding emission factors estimated using EPA's MOVES model.[363] To estimate emissions (including CO_2) from upstream processes involved in producing, distributing, and delivering fuel, NHTSA has applied emission factors—all specified on a gram per gallon basis—derived from Argonne National Laboratory's GREET model.[364]

(l) Refueling Time Benefits

To estimate the value of time savings associated with vehicle refueling, the Method A analysis used estimates that an average refueling event involves refilling 60 percent of the tank's capacity over the course of 3.5 minutes, at an hourly cost of $27.22.

(m) External Costs of Travel

Changes in vehicle travel will entail economic externalities. To estimate these costs, the Method A analysis used estimates that congestion-, accident-, and noise-related externalities will total 5.1 ¢/mi., 2.8 ¢/mi., and 0.1 ¢/mi., respectively.

(n) Ownership and Operating Costs

Method A results predict that the total cost of vehicle ownership and operation will change not just due to changes in vehicle price and fuel outlays, but also due to some other costs likely to vary with vehicle price. To estimate these costs, NHTSA has applied factors of 5.5 percent (of price) for taxes and fees, 15.3 percent for financing, 19.2 percent for insurance, 1.9 percent for relative value loss. The Method A analysis also estimates that average vehicle resale value will increase by 25 percent of any increase in new vehicle price.

(5) DOT CAFE Model Analysis of Impacts of Regulatory Alternatives for HD Pickups and Vans

(a) Industry Impacts

The agencies' analysis fleet provides a starting point for estimating the extent to which manufacturers might add fuel-saving (and, therefore, CO_2-avoiding) technologies under various regulatory alternatives, including the no-action alternative that defines a baseline against which to measure estimated impacts of new standards. The analysis fleet is a forward-looking projection of production of new HD pickups and vans, holding vehicle characteristics (*e.g.,* technology content and fuel consumption levels) constant at model year 2014 levels, and adjusting production volumes based on recent DOE and commercially-available forecasts. This analysis fleet includes some significant changes relative to the market characterization that was used to develop the Phase 1 standards applicable starting in model year 2014; in particular, the analysis fleet includes some new HD vans (*e.g.,* Ford's Transit and Fiat/Chrysler's Promaster) that are considerably more fuel-efficient than HD vans these manufacturers have previously produced for the U.S. market.

While the proposed standards are scheduled to begin in model year 2021, the requirements they define are likely to influence manufacturers' planning decisions several years in advance. This is true in light-duty planning, but accentuated by the comparatively long redesign cycles and small number of models and platforms offered for sale in the 2b/3 market segment. Additionally, manufacturers will respond to the cost and efficacy of available fuel consumption improvements, the price of fuel, and the requirements of the Phase 1 standards that specify maximum allowable average fuel consumption and GHG levels for MY2014–MY2018 HD pickups and vans (the final standard for MY2018 is held constant for model years 2019 and 2020). The forward-looking nature of product plans that determine which vehicle models will be offered in the model years affected by the proposed standards lead to additional technology application to vehicles in the analysis fleet that occurs in the years prior to the start of the proposed standards. From the industry perspective, this means that manufacturers will incur costs to comply with the proposed standards in the baseline and that the total cost of the proposed regulations will include some costs that occur prior to their start, and represent incremental changes over a world in which manufacturers will have already modified their vehicle offerings compared to today.

[363] EPA MOVES model available at *http://www.epa.gov/otaq/models/moves/index.htm* (last accessed Feb 23, 2015).

[364] GREET (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) Model, Argonne National Laboratory, *https://greet.es.anl.gov/.*

TABLE VI–19—MY2021 BASELINE COSTS FOR MANUFACTURERS IN 2b/3 MARKET SEGMENT IN THE DYNAMIC BASELINE, OR ALTERNATIVE 1b

Manufacturer	Average technology cost ($)	Total cost increase ($m)
Chrysler/Fiat	275	27
Daimler	18	0
Ford	258	78
General Motors	782	191
Nissan	282	3
Industry	442	300

As Table VI–19 shows, the industry as a whole is expected to add about $440 of new technology to each new vehicle model by 2021 under the no-action alternative defined by the Phase 1 standards. Reflecting differences in projected product offerings in the analysis fleet, some manufacturers (notably Daimler) are significantly less constrained by the Phase 1 standards than others and face lower cost increases as a result. General Motors (GM) shows the largest increase in average vehicle cost, but results for GM's closest competitors (Ford and Chrysler/Fiat) do not include the costs of their recent van redesigns, which are already present in the analysis fleet (discussed in greater detail below).

The above results reflect the assumption that manufacturers having achieved compliance with standards might act as if buyers are willing to pay for further fuel consumption improvements that ''pay back'' within 6 months (*i.e.,* those improvements whose incremental costs are exceeded by savings on fuel within the first six months of ownership). It is also possible that manufacturers will choose not to migrate cost-effective technologies to the 2b/3 market segment from similar vehicles in the light-duty market. To examine this possibility, all regulatory alternatives were also analyzed using the DOT CAFE model (Method A) with a 0-month payback period in lieu of the 6-month payback period discussed above. (A sensitivity analysis using Method A, discussed below, also explores longer payback periods, as well as the combined effect of payback period and fuel price on vehicle design decisions). Resultant technology costs in model year 2021 results for the no-action alternative, summarized in Table VI–20 below, are quite similar to those shown above for the 6-month payback period. Due to the similarity between the two baseline characterizations, results in the following discussion represent differences relative to only the 6-month payback baseline.

TABLE VI–20—MY2021 BASELINE COSTS FOR HD PICKUPS AND VANS IN THE FLAT BASELINE, OR ALTERNATIVE 1A

Manufacturer	Average technology cost ($)	Total cost increase ($m)
Chrysler/Fiat	268	27
Daimler	0	0
Ford	248	75
General Motors	767	188
Nissan	257	3
Industry	431	292

The results below represent the impacts of several regulatory alternatives, including those defined by the proposed standards, as incremental changes over the baseline, where the baseline is defined as the state of the world in the absence of the proposed regulatory action. Large-scale, macroeconomic conditions like fuel prices are constant across all alternatives, including the baseline, as are the fuel economy improvements under the no-action alternative defined by the Phase 1 MDHD rulemaking that covers model years 2014–2018 and is constant from model year 2018 through 2020. In the baseline scenario, the Phase 1 standards are assumed to remain in place and at 2018 levels throughout the analysis (*i.e.* MY 2030). The only difference between the definitions of the alternatives is the stringency of the proposed standards starting in MY 2021 and continuing through either MY 2025 or MY 2027, and all of the differences in outcomes across alternatives are attributable to differences in the standards.

The standards vary in stringency across regulatory alternatives (1–5), but as discussed above, all of the standards are based on the curve developed in the Phase 1 standards that relate fuel economy and GHG emissions to a vehicle's work factor. The alternatives considered here represent different rates of annual increase in the curve defined for model year 2018, growing from a 0 percent annual increase (Alternative 1, the baseline or ''no-action'' alternative) up to a 4 percent annual increase (Alternative 5). Table VI–21 shows a summary [365] of outcomes by alternative incremental to the baseline (Alternative 1b) for Model Year 2030 [366], with the exception of technology penetration rates, which are absolute.

The technologies applied by the CAFE model have been grouped (in most cases) to give readers a general sense of which types of technology are applied more frequently than others, and are more likely to be offered in new class 2b/3 vehicles once manufacturers are fully compliant with the standards in the alternative. Model year 2030 was chosen to account for technology application that occurs once the standards have stabilized, but manufacturers are still redesigning products to achieve compliance—generating technology costs and benefits in those model years. The summaries of technology penetration are also intended to reflect the relationship between technology application and cost increases across the alternatives. The table rows present the degree to which specific technologies will be present in new class 2b and class 3 vehicles in 2030, and correspond to: Variable valve timing (VVT) and/or variable valve lift (VVL), cylinder deactivation, direct injection, engine turbocharging, 8-speed automatic transmissions, electric power-steering and accessory improvements, micro-hybridization (which reduces engine idle, but does not assist propulsion), full hybridization (integrated starter generator or strong hybrid that assists propulsion and recaptures braking energy), and aerodynamic improvements to the vehicle shape. In addition to the technologies in the following tables, there are some lower-complexity technologies that have high market penetration across all the alternatives and manufacturers; low rolling-resistance tires, low friction lubricants, and reduced engine friction, for example.

365 NHTSA generated hundreds of outputs related to economic and environmental impacts, each available technology, and the costs associated with the rule. A more comprehensive treatment of these outputs appears in Chapter 10 of the draft RIA.

366 The DOT CAFE model estimates that redesign schedules will ''straddle'' model year 2027, the latest year for which the agencies are proposing increases in the stringency of fuel consumption and GHG standards. Considering also that today's analysis estimates some earning and application of ''carried forward'' compliance credits, the model was run extending the analysis through model year 2030.

TABLE VI–21—SUMMARY OF HD PICKUPS AND VANS ALTERNATIVES' IMPACT ON INDUSTRY VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b

Alternative	2	3	4	5
Annual Stringency Increase	2.0%/y	2.5%/y	3.5%/y	4.0%/y
Stringency Increase Through MY	2025	2027	2025	2025
Total Stringency Increase	9.6%	16.2%	16.3%	18.5%
Average Fuel Economy (miles per gallon)				
Required	19.04	20.57	20.57	21.14
Achieved	19.14	20.61	20.83	21.27
Average Fuel Consumption (gallons/100 mi.)				
Required	5.25	4.86	4.86	4.73
Achieved	5.22	4.85	4.80	4.70
Average Greenhouse Gas Emissions (g/mi)				
Required	495	458	458	446
Achieved	491	458	453	444
Technology Penetration (%)				
VVT and/or VVL	46	46	46	46
Cylinder Deac	29	21	21	21
Direct Injection	17	25	31	32
Turbocharging	55	63	63	63
8-Speed AT	67	96	96	97
EPS, Accessories	54	80	79	79
Stop Start	0	0	10	13
Hybridization [a]	0	8	35	51
Aero. Improvements	36	78	78	78
Mass Reduction (vs. No-Action)				
CW (lb.)	239	243	325	313
CW (%)	3.7	3.7	5.0	4.8
Technology Cost (vs. No-Action)				
Average ($) [b]	578	1,348	1,655	2,080
Total ($m) [c]	437	1,019	1,251	1,572
Payback period (m) [c]	25	31	34	38

Notes:
[a] Includes mild hybrids (ISG) and strong HEVs.
[b] Values used in Methods A & B.
[c] Values used in Method A, calculated using a 3% discount rate.

In general, the model projects that the standards would cause manufacturers to produce HD pickups and vans that are lighter, more aerodynamic, and more technologically complex across all the alternatives. As Table VI–21 shows, there is a difference between the relatively small increases in required fuel economy and average incremental technology cost between the alternatives, suggesting that the challenge of improving fuel consumption and CO_2 emissions accelerates as stringency increases (*i.e.,* that there may be a ''knee'' in the relationship between technology cost and reductions in fuel consumption/ GHG emissions). Despite the fact that the required average fuel consumption level changes by about 3 percent between Alternative 4 and Alternative 5, average technology cost increases by more than 25 percent. These differences help illustrate the clustered character of this market segment, where relatively small increases in fuel economy can lead to much larger cost increases if entire platforms must be changed in response to the standards.

The contrast between alternatives 3 and 4 is even more prominent, with an identical required fuel economy improvement leading to price increases greater than 20 percent based on the more rapid rate of increase and shorter time span of Alternative 4, which achieves all of its increases by MY 2025 while Alternative 3 continues to increase at a slower rate until MY 2027. Despite these differences, the increase in average payback period when moving from Alternative 3 to Alternative 4 to Alternative 5 is fairly constant at around an additional three months for each jump in stringency.

Manufacturers offer few models, typically only a pickup truck and/or a cargo van, and while there are a large number of variants of each model, the degree of component sharing across the variants can make diversified technology application either economically impractical or impossible. This forces manufacturers to apply some technologies more broadly in order to achieve compliance than they might do in other market segments (passenger cars, for example). This difference between broad and narrow application—where some technologies must be applied to entire platforms, while some can be applied to individual model variants—also explains why certain technology penetration rates decrease between alternatives of increasing stringency (cylinder deactivation or mass reductions in Table VI–21, for example). For those cases, narrowly applying a more advanced (and costly) technology can be a more cost effective path to compliance and lead to reductions in the amount of lower-complexity technology that is applied.

One driver of the change in technology cost between Alternative 3 and Alternative 4 is the amount of hybridization projected to result from the implementation of the standards. While only about 5 percent full hybridization (defined as either integrated starter-generator or strong hybrid) is expected to be needed to comply with Alternative 3, the higher rate of increase and compressed schedule moving from Alternative 3 to Alternative 4 is enough to increase the percentage of the fleet adopting full hybridization by a factor of two. To the extent that manufacturers are concerned about introducing hybrid vehicles in the 2b and 3 market, it is worth noting that new vehicles subject to Alternative 3 achieve the same fuel economy as new vehicle subject to Alternative 4 by 2030, with less hybridization required to achieve the improvement.

The alternatives also lead to important differences in outcomes at the manufacturer level, both from the industry average and from each other. General Motors, Ford, and Chrysler (Fiat), are expected to have approximately 95 percent of the 2b/3 new vehicle market during the years that the proposed standards are being phased in. Due to their importance to this market and the similarities between their model offerings, these three manufacturers are discussed together and a summary of the way each is impacted by the standards appears below in Table VI–22, Table VI–23, and Table VI–24 for General Motors, Ford, and Chrysler/Fiat, respectively.

TABLE VI–22—SUMMARY OF IMPACTS ON GENERAL MOTORS BY 2030 IN THE HD PICKUP AND VAN MARKET VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b

Alternative	2	3	4	5
Annual Stringency Increase	2.0%/y	2.5%/y	3.5%/y	4.0%/y
Stringency Increase Through MY	2025	2027	2025	2025
Average Fuel Economy (miles per gallon)				
Required	18.38	19.96	20	20.53
Achieved	18.43	19.95	20.24	20.51
Average Fuel Consumption (gallons/100 mi.)				
Required	5.44	5.01	5	4.87
Achieved	5.42	5.01	4.94	4.87
Average Greenhouse Gas Emissions (g/mi)				
Required	507	467	467	455
Achieved	505	468	461	455
Technology Penetration (%)				
VVT and/or VVL	64	64	64	64
Cylinder Deac	47	47	47	47
Direct Injection	18	18	36	36
Turbocharging	53	53	53	53
8-Speed AT	36	100	100	100
EPS, Accessories	100	100	100	100
Stop Start	0	0	2	0
Hybridization	0	19	79	100
Aero. Improvements	100	100	100	100
Mass Reduction (vs. No-Action)				
CW (lb.)	325	161	158	164
CW (%)	5.3	2.6	2.6	2.7
Technology Cost (vs. No-Action)				
Average ($) [a]	785	1,706	2,244	2,736
Total ($m, undiscounted) [b]	214	465	611	746

Notes:
[a] Values used in Methods A & B.
[b] Values used in Method A, calculated at a 3% discount rate.

TABLE VI–23—SUMMARY OF IMPACTS ON FORD BY 2030 IN THE HD PICKUP AND VAN MARKET VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b

Alternative	2	3	4	5
Annual Stringency Increase	2.0%/y	2.5%/y	3.5%/y	4.0%/y

TABLE VI–23—SUMMARY OF IMPACTS ON FORD BY 2030 IN THE HD PICKUP AND VAN MARKET VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b—Continued

Alternative	2	3	4	5
Stringency Increase Through MY	2025	2027	2025	2025
Average Fuel Economy (miles per gallon)				
Required	19.42	20.96	20.92	21.51
Achieved	19.5	21.04	21.28	21.8
Average Fuel Consumption (gallons/100 mi.)				
Required	5.15	4.77	4.78	4.65
Achieved	5.13	4.75	4.70	4.59
Average Greenhouse Gas Emissions (g/mi)				
Required	485	449	450	438
Achieved	482	447	443	433
Technology Penetration (%)				
VVT and/or VVL	34	34	34	34
Cylinder Deac	18	0	0	0
Direct Injection	16	34	34	34
Turbocharging	51	69	69	69
8-Speed AT	100	100	100	100
EPS, Accessories	41	62	59	59
Stop Start	0	0	20	29
Hybridization	0	2	14	30
Aero. Improvements	0	59	59	59
Mass Reduction (vs. No-Action)				
CW (lb.)	210	202	379	356
CW (%)	3.2	3	5.7	5.3
Technology Cost (vs. No-Action)				
Average ($) [a]	506	1,110	1,353	1,801
Total ($m, undiscounted) [b]	170	372	454	604

Notes:
[a] Values used in Methods A & B.
[b] Values used in Method A, calculated at a 3% discount rate.

TABLE VI–24—SUMMARY OF IMPACTS ON FIAT/CHRYSLER BY 2030 IN THE HD PICKUP AND VAN MARKET VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b

Alternative	2	3	4	5
Annual Stringency Increase	2.0%/y	2.5%/y	3.5%/y	4.0%/y
Stringency Increase Through MY	2025	2027	2025	2025
Average Fuel Economy (miles per gallon)				
Required	18.73	20.08	20.12	20.70
Achieved	18.83	20.06	20.10	20.70
Average Fuel Consumption (gallons/100 mi.)				
Required	5.34	4.98	4.97	4.83
Achieved	5.31	4.99	4.97	4.83
Average Greenhouse Gas Emissions (g/mi)				
Required	515	480	479	466
Achieved	512	481	480	467
Technology Penetration (%)				
VVT and/or VVL	40	40	40	40
Cylinder Deac	23	23	23	23
Direct Injection	17	17	17	17
Turbocharging	74	74	74	74

TABLE VI–24—SUMMARY OF IMPACTS ON FIAT/CHRYSLER BY 2030 IN THE HD PICKUP AND VAN MARKET VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b—Continued

Alternative	2	3	4	5
8-Speed AT	65	88	88	88
EPS, Accessories	0	100	100	100
Stop-Start	0	0	0	0
Hybridization	0	3	3	10
Aero. Improvements	0	100	100	100
Mass Reduction (vs. No-Action)				
CW (lb.)	196	649	648	617
CW (%)	2.8	9.1	9.1	8.7
Technology Cost (vs. No-Action)				
Average ($) [a]	434	1,469	1,486	1,700
Total ($m, undiscounted) [b]	48	163	164	188

Notes:
[a] Values used in Methods A & B.
[b] Values used in Method A, calculated at a 3% discount rate.

The fuel consumption and GHG standards require manufacturers to achieve an average level of compliance, represented by a sales-weighted average across the specific targets of all vehicles offered for sale in a given model year, such that each manufacturer will have a unique required consumption/emissions level determined by the composition of its fleet, as illustrated above. However, there are more interesting differences than the small differences in required fuel economy levels among manufacturers. In particular, the average incremental technology cost increases with the stringency of the alternative for each manufacturer, but the size of the cost increase from one alternative to the next varies among them, with General Motors showing considerably larger increases in cost moving from Alternative 3 to Alternative 4, than from either Alternative 2 to Alternative 3 or Alternative 4 to Alternative 5. Ford is estimated to have more uniform cost increases from each alternative to the next, in increasing stringency, though still benefits from the reduced pace and longer period of increase associated with Alternative 3 compared to Alternative 4.

The simulation results show all three manufacturers facing cost increases when the stringency of the standards move from 2.5 percent annual increases over the period from MY 2021–2027 to 3.5 percent annual increases from MY 2021–2025, but General Motors has the largest at 75 percent more than the industry average price increase for Alternative 4. GM also faces higher cost increases in Alternative 2 about 50 percent more than either Ford or Fiat/Chrysler. And for the most stringent alternative considered, the agencies estimate that General Motors would face average cost increases of more than $2,700, in addition to the more than $700 increase in the baseline—approaching nearly $3,500 per vehicle over today's prices.

Technology choices also differ by manufacturer, and some of those decisions are directly responsible for the largest cost discrepancies. For example, GM is estimated to engage in the least amount of mass reduction among the Big 3 after Phase 1, and much less than Chrysler/Fiat, but reduces average vehicle mass by over 300 lbs in the baseline—suggesting that some of GM's easiest Phase 1 compliance opportunities can be found in lightweighting technologies. Similarly, Chrysler/Fiat is projected to apply less hybridization than the others, and much less than General Motors, which is simulated to have full hybrids (either integrated starter generator or complete hybrid system) on all of its fleet by 2030, nearly 20 percent of which will be strong hybrids, in Alternative 4 and the strong hybrid share decreases to about 18 percent in Alternative 5, as some lower level technologies are applied more broadly. Because the analysis applies the same technology inputs and the same logic for selecting among available opportunities to apply technology, the unique situation of each manufacturer determined which technology path is projected as the most cost-effective.

In order to understand the differences in incremental technology costs and fuel economy achievement across manufacturers in this market segment, it is important to understand the differences in their starting position relative to the proposed standards. One important factor, made more obvious in the following figures, is the difference between the fuel economy and performance of the recently redesigned vans offered by Fiat/Chrysler and Ford (the Promaster and Transit, respectively), and the more traditionally-styled vans that continue to be offered by General Motors (the Express/Savannah). In MY 2014, Ford began the phase-out of the Econoline van platform, moving those volumes to the Euro-style Transit vans (discussed in more detail in Section VI. D.2). The Transit platform represents a significant improvement over the existing Econoline platform from the perspective of fuel economy, and for the purpose of complying with the standards, the relationship between the Transit's work factor and fuel economy is a more favorable one than the Econoline vans it replaces. Since the redesign of van offerings from both Chrysler/Fiat and Ford occur in (or prior to) the 2014 model year, the costs, fuel consumption improvements, and reductions of vehicle mass associated with those redesigns are included in the analysis fleet, meaning they are not carried as part of the compliance modeling exercise. By contrast, General Motors is simulated to redesign their van offerings after 2014, such that there is a greater potential for these vehicles to incur additional costs attributable to new standards, unlike the costs associated with the recent redesigns of their competitors. The inclusion of these new Ford and Chrysler/Fiat products in the analysis fleet is the primary driver of the cost discrepancy between GM and its competitors in both the baseline and Alternative 2, when Ford and Chrysler/

Fiat have to apply considerably less technology to achieve compliance.

The remaining 5 percent of the 2b/3 market is attributed to two manufacturers, Daimler and Nissan, which, unlike the other manufacturers in this market segment, only produce vans. The vans offered by both manufacturers currently utilize two engines and two transmissions, although both Nissan engines are gasoline engines and both Daimler engines are diesels. Despite the logical grouping, these two manufacturers are impacted much differently by the proposed standards. For the least stringent alternative considered, Daimler adds no technology and incurs no incremental cost in order to comply with the standards. At stringency increases greater than or equal to 3.5 percent per year, Daimler only really improves some of their transmissions and improves the electrical accessories of its Sprinter vans. By contrast, Nissan's starting position is much weaker and their compliance costs closer to the industry average in Table VI–21. This difference could increase if the analysis fleet supporting the final rule includes forthcoming Nissan HD pickups.

TABLE VI–25—SUMMARY OF IMPACTS ON DAIMLER BY 2030 IN THE HD PICKUP AND VAN MARKET VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b

Alternative	2	3	4	5
Annual Stringency Increase	2.0%/y	2.5%/y	3.5%/y	4.0%/y
Stringency Increase Through MY	2025	2027	2025	2025
Average Fuel Economy (miles per gallon)				
Required	23.36	25.19	25.25	25.91
Achieved	25.23	25.79	25.79	26.53
Average Fuel Consumption (gallons/100 mi.)				
Required	4.28	3.97	3.96	3.86
Achieved	3.96	3.88	3.88	3.77
Average Greenhouse Gas Emissions (g/mi)				
Required	436	404	404	393
Achieved	404	395	395	384
Technology Penetration (%)				
VVT and/or VVL	0	0	0	0
Cylinder Deac	0	0	0	0
Direct Injection	0	0	0	0
Turbocharging	44	44	44	44
8-Speed AT	0	44	44	100
EPS, Accessories	0	0	0	0
Stop-Start	0	0	0	0
Hybridization	0	0	0	0
Aero. Improvements	0	0	0	0
Mass Reduction (vs. No-Action)				
CW (lb.)	0	0	0	0
CW (%)	0	0	0	0
Technology Cost (vs. No-Action)				
Average ($) [a]	0	165	165	374
Total ($m, undiscounted) [b]	0	4	4	9

Notes:
[a] Values used in Methods A & B.
[b] Values used in Method A, calculated at a 3% discount rate.

TABLE VI–26—SUMMARY OF IMPACTS ON NISSAN BY 2030 IN THE HD PICKUP AND VAN MARKET VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b

Alternative	2	3	4	5
Annual Stringency Increase	2.0%/y	2.5%/y	3.5%/y	4.0%/y
Stringency Increase Through MY	2025	2027	2025	2025
Average Fuel Economy (miles per gallon)				
Required	19.64	21.19	20.92	21.46
Achieved	19.84	21.17	21.19	21.51

TABLE VI–26—SUMMARY OF IMPACTS ON NISSAN BY 2030 IN THE HD PICKUP AND VAN MARKET VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b—Continued

Alternative	2	3	4	5
Average Fuel Consumption (gallons/100 mi.)				
Required	5.09	44.72	4.78	4.66
Achieved	5.04	4.72	4.72	4.65
Average Greenhouse Gas Emissions (g/mi)				
Required	452	419	425	414
Achieved	448	419	419	413
Technology Penetration (%)				
VVT and/or VVL	100	100	100	100
Cylinder Deac	49	49	49	49
Direct Injection	51	51	51	100
Turbocharging	51	51	51	50
8-Speed AT	0	51	51	51
EPS, Accessories	0	100	100	100
Stop-Start	0	0	0	0
Hybridization	0	0	0	28
Aero. Improvements	0	100	100	100
Mass Reduction (vs. No-Action)				
CW (lb.)	0	0	307	303
CW (%)	0	0	5	4.9
Technology Cost (vs. No-Action)				
Average ($) [a]	378	1,150	1,347	1,935
Total ($m, undiscounted) [b]	5	15.1	17.7	25.4

Notes:
[a] Values used in Methods A & B.
[b] Values used in Method A, calculated at a 3% discount rate.

As Table VI–25 and Table VI–26 show, Nissan applies more technology than Daimler in the less stringent alternatives and significantly more technology with increasing stringency. The Euro-style Sprinter vans that comprise all of Daimler's model offerings in this segment put Daimler in a favorable position. However, those vans are already advanced—containing downsized diesel engines and advanced aerodynamic profiles. Much like the Ford Transit vans, the recent improvements to the Sprinter vans occurred outside the scope of the compliance modeling so the costs of the improvements are not captured in the analysis.

Although Daimler's required fuel economy level is much higher than Nissan's (in miles per gallon), Nissan starts from a much weaker position than Daimler and must incorporate additional engine, transmission, platform-level technologies (*e.g.* mass reduction and aerodynamic improvements) in order to achieve compliance. In fact, more than 25 percent of Nissan's van offerings are projected to contain integrated starter generators by 2030 in Alternative 5.

While the agencies do not allow sales volumes for any manufacturer (or model) to vary across regulatory alternatives in the analysis, it is conceivable that under the most stringent alternatives individual manufacturers could lose market share to their competitors if the prices of their new vehicles rise more than the industry average without compensating fuel savings and/or changes to other features.

(b) Estimated Owner/Operator Impacts With Respect to HD Pickups and Vans Using Method A

The owner/operator impacts of the proposed rules are more straightforward. Table VI–27 shows the impact on the average owner/operator who buys a new class 2b or 3 vehicle in model year 2030 using the worst case assumption that manufacturers pass through the entire cost of technology to the purchaser. (All dollar values are discounted at a rate of 7 percent per year from the time of purchase, except the average price increase, which occurs at the time of purchase). The additional costs associated with increases in taxes, registration fees, and financing costs are also captured in the table.

TABLE VI–27—SUMMARY OF INDIVIDUAL OWNER/OPERATOR IMPACTS IN MY 2030 IN THE HD PICKUP AND VAN MARKET SEGMENT USING METHOD A AND VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b [a]

Alternative	2	3	4	5
Annual Stringency Increase Increases	2.0%/y	2.5%/y	3.5%/y	4.0%/y
Stringency Increase Through MY	2025	2027	2025	2025

TABLE VI–27—SUMMARY OF INDIVIDUAL OWNER/OPERATOR IMPACTS IN MY 2030 IN THE HD PICKUP AND VAN MARKET SEGMENT USING METHOD A AND VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b [a]—Continued

Alternative	2	3	4	5
Value of Lifetime Fuel Savings (discounted 2012 dollars)				
Pretax	2,068	3,924	4,180	4,676
Tax	210	409	438	491
Total	2,278	4,334	4,618	5,168
Economic Benefits (discounted 2012 dollars)				
Mobility Benefit	244	437	472	525
Avoided Refueling Time	86	164	172	193
New Vehicle Purchase (vs. No-Action Alternative)				
Avg. Price Increase ($)	578	1,348	1,655	2,080
Avg. Payback (years)	2.5	3	3.4	3.9
Additional costs ($)	120	280	344	432
Net Lifetime Owner/Operator Benefits (discounted $)				
Total Net Benefits	1,910	3,307	3,263	3,374

Notes:
* All dollar values are discounted at a rate of 7 percent per year from the time of purchase, except the average price increase, which occurs at the time of purchase).
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

As expected, an owner/operator's lifetime fuel savings increase monotonically across the alternatives. The mobility benefit in Table VI–27 refers to the value of additional miles that an individual owner/operator travels as a result of reduced per-mile travel costs. The additional miles result in additional fuel consumption and represent foregone fuel savings, but are valued by owner/operators at the cost of the additional fuel plus the owner/operator surplus (a measure of the increase in welfare that owner/operators achieve by having more mobility). The refueling benefit measures the value of time saved through reduced refueling events, the result of improved fuel economy and range in vehicles that have been modified in response to the standards.

There are some limitations to using payback period as a measure, as it accounts for fuel expenditures and incremental costs associated with taxes, registration fees and financing, and increased maintenance costs, but not the cost of potential repairs or replacements, which may or may not be more expensive with more advanced technology.

Overall, the average owner/operator is likely to see discounted lifetime benefits that are multiples of the price increases faced when purchasing the new vehicle in MY 2030 (or the few model years preceding 2030). In particular, the net present value of future benefits at the time of purchase are estimated to be 3.5, 3.0, 2.2, and 1.8 times the price increase of the average new MY2030 vehicle for Alternatives 2–5, respectively. As Table VI–27 illustrates, the preferred alternative has the highest ratio of discounted future owner/operator benefits to owner/operator costs.

(c) Estimated Social and Environmental Impacts for HD Pickups and Vans

Social benefits increase with the increasing stringency of the alternatives. As in the owner/operator analysis, the net benefits continue to increase with increasing stringency—suggesting that benefits are still increasing faster than costs for even the most stringent alternative.

TABLE VI–28—SUMMARY OF TOTAL SOCIAL COSTS AND BENEFITS THROUGH MY 2029 IN THE HD PICKUP AND VAN MARKET SEGMENT USING METHOD A AND VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b [a]

Alternative	2	3	4	5
Annual Stringency Increase	2.0%	2.5%	3.5%	4.0%
Stringency Increase Through MY	2025	2027	2025	2025
Fuel Purchases ($billion)				
Pretax Savings	9.6	15.9	19.1	22.2
Fuel Externalities ($billion)				
Energy Security	0.5	0.9	1.1	1.3
CO_2 emissions [b]	1.9	3.2	3.8	4.4
VMT-Related Externalities ($billion)				
Driving Surplus	1.1	1.8	2.1	2.4
Refueling Surplus	0.4	0.7	0.8	0.9

TABLE VI–28—SUMMARY OF TOTAL SOCIAL COSTS AND BENEFITS THROUGH MY 2029 IN THE HD PICKUP AND VAN MARKET SEGMENT USING METHOD A AND VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b [a]—Continued

Alternative	2	3	4	5
Congestion	−0.2	−0.4	−0.4	−0.5
Accidents	−0.1	−0.2	−0.2	−0.3
Noise	0	0	0	0
Fatalities	0.1	−0.2	−0.2	−0.5
Criteria Emissions	0.6	1.1	1.3	1.6
Technology Costs vs. No-Action ($billion)				
Incremental Cost	2.5	5.0	7.2	9.7
Additional Costs	0.5	1.0	1.5	2.0
Benefit Cost Summary ($billion)				
Total Social Cost	3.3	6.8	9.5	13.0
Total Social Benefit	13.9	22.7	27.4	31.7
Net Social Benefit	10.6	15.9	17.9	18.7

Notes:

* All dollar values are discounted at a rate of 3 percent per year from the time of purchase.

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Using the 3% average social cost of CO_2 value. There are four distinct social cost of CO_2 values presented in the *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866 (2010 and 2013).* The CO_2 emissions presented here would be valued lower with one of those other three values and higher at the other two values.

Table VI–28 provides a summary of benefits and costs, cumulative from MY2015–MY2029 (although the early years of the series typically have no incremental costs and benefits over the baseline), for each alternative. In the social perspective, fuel savings are considered net of fuel taxes, which are a transfer from purchasers of fuel to society at large. The energy security component represents the risk premium associated with exposure to oil price spikes and the economic consequences of adapting to them. This externality is monetized on a per-gallon basis, just as the social cost of carbon is used in this analysis. Just as the previous two externalities are caused by fuel consumption, others are caused by travel itself. The additional VMT resulting from the increase in travel demand that occurs when the price of driving decreases (*i.e.* the rebound effect), not only leads to increased mobility (which is a benefit to drivers), but also to increases in congestion, noise, accidents, and per-mile emissions of criteria pollutants like carbon monoxide and diesel particulates. Although increases in VMT lead to increases in tailpipe emissions of criteria pollutants, the proposed regulations decrease overall consumption enough that the emissions reductions associated with the remainder of the fuel cycle (extraction, refining, transportation and distribution) are large enough to create a net reduction in the emissions of criteria pollutants (shown below in Table VI–29 and VI–30).[367] A full presentation of the costs and benefits, and the considerations that have gone into each cost and benefit category—such as how energy security premiums were developed, how the social costs of carbon and co-pollutant benefits were developed, etc.—is presented in Section IX of this preamble and in Chapters 7 and 8 of the draft RIA for each regulated segment (engines, HD pickups and vans, vocational vehicles, tractors and trailers).

Another side effect of increased VMT is the likely increase in crashes, which is a function of the total vehicle travel in each year. Although additional crashes could involve additional fatalities, we estimate that this potential could be partially offset by the application of mass reduction to HD pickup trucks and vans, which could make fatalities less likely in some crashes involving these vehicles. As Table VI–28 illustrates, the social cost associated with traffic fatalities is the result of an additional −10 (Alternative 2 leads to a reduction in fatalities over the baseline, due to the application of mass reduction technologies), 35, 36, and 66 fatalities for Alternatives 2–5, respectively. The baseline contains nearly 25,000 fatalities involving 2b/3 vehicles over the same period. The incremental fatalities associated with Alternative 2–5 are −0.4, 0.1, 0.1, and 0.3 percent relative to the MYs 2015–2029 baseline, respectively.

The CAFE model was used to estimate the emissions impacts of the various alternatives that are the result of lower fuel consumption, but increased vehicle miles traveled for vehicle produced in model years subject to the standards in the alternatives. Criteria pollutants are largely the result of vehicle use, and accrue on a per-mile-of-travel basis, but the alternatives still generally lead to emissions reductions. Although vehicle use increases under each of the alternatives, upstream emissions associated with fuel refining, transportation and distribution are reduced for each gallon of fuel saved and that savings is larger than the incremental increase in emissions associated with increased travel. The net of the two factors is a savings of criteria (and other) pollutant emissions.

[367] For a more detailed discussion of the results from the CAFE Model on the proposed heavy duty pickups and vans regulation's impact on emissions of CO_2 and criteria pollutants, see NHTSA's accompanying Draft Environmental Impact Statement.

TABLE VI–29—SUMMARY OF ENVIRONMENTAL IMPACTS THROUGH MY2029 IN THE HD PICKUP AND VAN MARKET SEGMENT, USING METHOD A AND VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1b [a]

Alternative	2	3	4	5
Annual Stringency Increase	2.0%	2.5%	3.5%	4.0%
Stringency Increase Through MY	2025	2027	2025	2025
Greenhouse Gas Emissions vs. No-Action Alternative				
CO_2 (MMT)	54	91	110	127
CH4 and N_2O (tons)	65,600	111,400	133,700	155,300
Other Emissions vs. No-Action Alternative (tons)				
CO	10,400	20,700	25,800	30,400
VOC and NO_X	23,800	43,600	53,500	62,200
PM	1,470	2,550	3,090	3,590
SO_2	11,400	19,900	24,100	28,000
Air Toxics	44	47	49	55
Diesel PM_{10}	2,470	4,350	5,300	6,160
Other Emissions vs. No-Action Alternative (% reduction)				
CO	0.1	0.3	0.4	0.4
VOC and NO_X	1.1	2.1	2.6	3.0
PM	1.7	3.0	3.6	4.2
SO_2	2.9	5.1	6.2	7.2
Air Toxics	0.1	0.1	0.1	0.2
Diesel PM_{10}	2.7	4.8	5.9	6.8

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

In addition to comparing environmental impacts of the alternatives against a dynamic baseline that shows some improvement over time, compared to today's fleet, even in the absence of the alternatives, the environmental impacts from the Method A analysis were compared against a flat baseline. This other comparison is summarized below, but both comparisons are discussed in greater detail in the Draft EIS.

TABLE VI–30—SUMMARY OF ENVIRONMENTAL IMPACTS THROUGH MY2029 IN THE HD PICKUP AND VAN MARKET SEGMENT, USING METHOD A AND VERSUS THE FLAT BASELINE, ALTERNATIVE 1 [a]

Alternative	2	3	4	5
Annual Stringency Increase	2.0%	2.5%	3.5%	4.0%
Stringency Increase Through MY	2025	2027	2025	2025
Greenhouse Gas Emissions vs. No-Action Alternative				
CO_2 (MMT)	66	105	127	142
CH_4 and N_2O (tons)	79,700	127,400	154,800	172,800
Other Emissions vs. No-Action Alternative (tons)				
CO	11,630	22,160	28,030	32,370
VOC and NO_X	28,280	48,770	60,180	68,050
PM	1,780	2,900	3,550	3,980
SO_2	13,780	22,580	27,660	31,020
Air Toxics	60	65	72	73
Diesel PM_{10}	2,980	4,930	6,060	6,810
Other Emissions vs. No-Action Alternative (% reduction)				
CO	0.2	0.3	0.4	0.4
VOC and NO_X	1.4	2.3	2.9	3.3
PM	2.1	3.4	4.2	4.7
SO_2	3.5	5.7	7.0	7.9
Air Toxics	0.2	0.2	0.2	0.2
Diesel PM_{10}	3.3	5.4	6.7	7.5

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(6) Sensitivity Analysis Evaluating Different Inputs to the DOT CAFE Model

This section describes some of the principal sensitivity results, obtained by running the various scenarios describing the policy alternatives with alternative inputs. OMB Circular A–4 indicates that ''it is usually necessary to provide a sensitivity analysis to reveal whether, and to what extent, the results of the analysis are sensitive to plausible changes in the main assumptions and numeric inputs.'' [368] Considering this guidance, a number of sensitivity analyses were performed using analysis Method A to examine important assumptions and inputs, including the following, all of which are discussed in greater detail in the accompanying RIA:

1. *Payback Period:* In addition to the 0 and 6 month payback periods discussed above, also evaluated cases involving payback periods of 12, 18, and 24 months.

2. *Fuel Prices:* Evaluated cases involving fuel prices from the AEO 2014 low and high oil price scenarios. (See AEO-Low and AEO-High in the tables.)

3. *Fuel Prices and Payback Period:* Evaluated one side case involving a 0 month payback period combined with fuel prices from the AEO 2014 low oil price scenario, and one side case with a 24 month payback period combined with fuel prices from the AEO 2014 high oil price scenario.

4. *Benefits to Vehicle Buyers:* The main Method A analysis assumes there is no loss in value to owner/operators resulting from vehicles that have an increase in price and higher fuel economy. NHTSA performed this sensitivity analysis assuming that there is a 25, or 50 percent loss in value to owner/operators—equivalent to the assumption that owner/operators will only value the calculated benefits they will achieve at 75, or 50 percent, respectively, of the main analysis estimates. (These are labeled as 75pctOwner/operatorBenefit and 50pctOwner/operatorBenefit.)

5. *Value of Avoided GHG Emissions:* Evaluated side cases involving lower and higher valuation of avoided CO_2 emissions, expressed as the social cost of carbon (SCC).

6. *Rebound Effect:* Evaluated side cases involving rebound effect values of 5 percent, 15 percent, and 20 percent. (These are labeled as 05PctReboundEffect, 15PctReboundEffect and 20PctReboundEffect).

7. *RPE-based Markup:* Evaluated a side case using a retail price equivalent (RPE) markup factor of 1.5 for non-electrification technologies, which is consistent with the NAS estimation for technologies manufactured by suppliers, and a RPE markup factor of 1.33 for electrification technologies (mild and strong HEV).

8. *ICM-based Post-Warranty Repair Costs:* NHTSA evaluated a side case that scaled the frequency of repair by vehicle survival rates, assumes that per-vehicle repair costs during the post-warranty period are the same as in the in-warranty period, and that repair costs are proportional to incremental direct costs (therefore vehicles with additional components will have increased repair costs).

9. *Mass-Safety Effect:* Evaluated side cases with the mass-safety impact coefficient at the values defining the 5th and 95th percent points of the confidence interval estimated in the underlying statistical analysis. (These are labeled MassFatalityCoeff05pct and MassFatalityCoeff95pct.)

10. *Strong HEVs:* Evaluated a side case in which strong HEVs were excluded from the set of technology estimated to be available for HD pickups and vans through model year 2030. As in Section VI.C. (8), this ''no SHEV'' case allowed turbocharging and downsizing on all GM vans to provide a lower-cost path for compliance.

11. *Diesel Downsizing:* Evaluated a side case in which downsizing of diesel engines was estimated to be more widely available to HD pickups and vans.

12. *Technology Effectiveness:* Evaluated side cases involving inputs reflecting lower and higher impacts of technologies on fuel consumption.

13. *Technology Direct Costs:* Evaluated side cases involving inputs reflecting lower and higher direct incremental costs for fuel-saving technologies.

14. *Fleet Mix:* Evaluated a side case in which the shares of individual vehicle models and configurations were kept constant at estimated current levels.

Table VI–31 below, summarizes key metrics for each of the cases included in the sensitivity analysis using Method A for the proposed alternative. The table reflects the percent change in the metrics (columns) relative to the main analysis, due to the particular sensitivity case (rows) for the proposed alternative 3. For each sensitivity run, the change in the metric can we described as the difference between the baseline and the preferred alternative for the sensitivity case, minus the difference between the preferred alternative and the baseline in the main analysis, divided by the difference between the preferred alternative and the baseline in the main analysis. Or,

$$Table\ Metric = \frac{\Delta_{Alt\ sen\ case} - \Delta_{Alt\ main\ run}}{\Delta_{Alt\ main\ run}} \cdot 100$$

Each metric represents the sum of the impacts of the preferred alternative over the model years 2018–2029, and the percent changes in the table represent percent changes to those sums. More detailed results for all alternatives are available in the accompanying RIA Chapter 10.

TABLE VI–31—SENSITIVITY ANALYSIS RESULTS FROM CAFE MODEL IN THE HD PICKUP AND VAN MARKET SEGMENT USING METHOD A AND VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1B (2.5% GROWTH IN STRINGENCY: CELLS ARE PERCENT CHANGE FROM BASE CASE) [A]

Sensitivity case	Fuel savings (gallons) (%)	CO2 savings (MMT) (%)	Fuel savings ($) (%)	Social costs (%)	Social benefits (%)	Social net benefits (%)
0 Month Payback	14.0	14.5	15.1	5.6	15.1	18.2

[368] Available at *http://www.whitehouse.gov/omb/circulars_a004_a-4/*.

TABLE VI–31—SENSITIVITY ANALYSIS RESULTS FROM CAFE MODEL IN THE HD PICKUP AND VAN MARKET SEGMENT USING METHOD A AND VERSUS THE DYNAMIC BASELINE, ALTERNATIVE 1B (2.5% GROWTH IN STRINGENCY: CELLS ARE PERCENT CHANGE FROM BASE CASE) [A]—Continued

Sensitivity case	Fuel savings (gallons) (%)	CO2 savings (MMT) (%)	Fuel savings ($) (%)	Social costs (%)	Social benefits (%)	Social net benefits (%)
12 Month Payback	−4.8	−4.7	−4.5	−2.5	−4.7	−5.4
18 Month Payback	−29.2	−28.1	−26.5	−14.1	−26.8	−31.1
24 Month Payback	−42.9	−42.4	−41.9	−23.2	−42.1	−48.4
AEO-Low	3.3	3.5	−27.9	−10.8	−22.2	−26.1
AEO-High	−7.0	−7.2	23.3	1.4	19.5	25.6
AEO-Low, 0 Month Payback	18.6	19.3	−16.5	−3.4	−10.1	−12.3
AEO-High, 24 Month Payback	−63.8	−64.6	−54.4	−49.9	−55.7	−57.7
50pct Owner/operator Benefit	0.0	0.0	−50.0	0.0	−34.6	−46.2
75pct Owner/operator Benefit	0.0	0.0	−25.0	0.0	−17.3	−23.1
Low SCC	0.0	0.0	0.0	0.0	−10.6	−14.1
Low SCC, 0 Month Payback	14.0	14.5	15.1	5.6	2.9	2.0
High SCC	0.0	0.0	0.0	0.0	7.8	10.4
High SCC, 0 Month Payback	14.0	14.5	15.1	5.6	24.0	30.1
Very High SCC	0.0	0.0	0.0	0.0	28.7	38.4
Very High SCC, 0 Month Payback	14.0	14.5	15.1	5.6	48.0	62.2
05 Pct Rebound Effect	4.6	4.6	4.6	−12.9	0.4	4.8
15 Pct Rebound Effect	−4.6	−4.6	−4.6	12.9	−0.4	−4.8
20 Pct Rebound Effect	−9.1	−9.2	−9.2	25.7	−0.8	−9.7
RPE-Based Markup	−3.2	−1.5	0.3	31.4	−0.1	−10.6
Mass Fatality Coeff 05pct	0.0	0.0	0.0	−23.6	0.0	7.9
Mass Fatality Coeff 95pct	0.0	0.0	0.0	23.9	0.0	−8.0
NoSHEVs	−6.7	−5.8	−5.0	2.3	−5.1	−7.6
NoSHEVs, 0 Month Payback	8.2	9.8	11.5	−1.2	11.3	15.4
Lower Effectiveness	−7.8	−7.8	−8.1	39.5	−8.0	−23.9
Higher Effectiveness	−10.6	−10.3	−10.0	−23.3	−10.2	−5.8
Lower Direct Costs	0.9	2.7	4.8	18.4	4.3	−0.4
Higher Direct Costs	−4.1	−3.8	−3.5	75.3	−3.8	−30.3
Wider Diesel Downsizing	−1.5	−1.0	−0.6	−10.3	−0.8	2.4
07 Pct Discount Rate	0.0	0.0	−100.0	−41.7	−100.0	−119.5
07 Pct DR, 0 Month Payback	14.0	14.5	−37.9	−30.7	−30.7	−30.7
Allow Gas To Diesel	15.5	5.3	−100.0	16.8	−100.0	−139.1
Allow Gas To Diesel, 0 Month Payback	32.1	22.6	14.5	46.8	17.0	7.0
flat mix after 2016	1.1	0.9	0.7	2.6	0.8	0.2

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

For some of the cases for which results are presented above, the sensitivity of results to changes in inputs is simple, direct, and easily observed. For example, changes to valuation of avoided GHG emissions impact only this portion of the estimated economic benefits; manufacturers' responses and corresponding costs are not impacted. Similarly, a higher discount rate does not affect physical quantities saved (gallons of fuel and metric tons of CO_2 in the table), but reduces the value of the costs and benefits attributable to the proposed standards in an intuitive way. Some other cases warrant closer consideration:

First, cases involving alternatives to the reference six-month payback period involve different degrees of fuel consumption improvement, and these differences are greatest in the no-action alternative defining the baseline. Because all estimated impacts of the proposed standards are shown as incremental values relative to this baseline, longer payback periods correspond to smaller estimates of incremental impacts, as fuel economy increasingly improves in the absence of the rule and manufacturers are compelled to add less technology in order to comply with the standards.

Second, cases involving different fuel prices similarly involve different degrees of fuel economy improvement in the absence of the standard, as more, or less, improvement occurs as a result of more, or fewer, technologies appearing cost effective to owner/operators. Lower fuel prices correspond to increases in fuel savings on a volumetric basis, as the standard is responsible for a greater amount of the fuel economy improvement, but the value of fuel savings decreases because each gallon saved is worth less when fuel prices are low. Higher fuel prices correspond to reductions in the volumetric fuel savings attributable to the proposed standards, but lead to increases in the value of fuel saved because each gallon saved is worth more when fuel prices are high.

Third, because the payback period and fuel price inputs work in opposing directions, the relative magnitude of each is important to consider for the combined sensitivity cases. While the low price and 0-month payback case leads to significant volumetric savings compared to the main analysis, the low fuel price is still sufficient to produce a negative change in net benefits. Similarly, the high price and 24-month payback case results in large reductions to volumetric savings that can be attributed to the proposed standards, but the presence of high fuel prices is not sufficient to lead to increases in either the dollar value of fuel savings or net social benefits.

Fourth, the cases involving different inputs defining the availability of some technologies do not impact equally the estimated impacts across all manufacturers. Section C.8 above provides a discussion of a sensitivity analysis that excludes strong hybrids and includes the use of downsized turbocharged engines in vans currently equipped with large V–8 engines. The modeling results for this analysis are provided in Section C.8 and in the table above. The no strong hybrid analysis shows that GM could comply with the proposed preferred Alternative 3 without strong hybrids based on the use of turbo downsizing on all of their HD gasoline vans. Alternatively, when the analysis is modified to allow for wider application of diesel engines, strong HEV application for GM drops slightly (from 19 percent to 17 percent) in MY2030, average per-vehicle costs drop slightly (by about $50), but MY2030 additional penetration rates of diesel engines increase by about 10 percent. Manufacturer-specific model results accompanying today's rules show the extent to which individual manufacturers' potential responses to the standards vary with these alternative assumptions regarding the availability and applicability of fuel-saving technologies. However, across all of these sensitivity cases, the model projects that social costs increase (as a result of increases in technology costs) when manufacturers choose to comply with the proposed regulations without the use of strong hybrids.

Fifth, the cases that vary the effectiveness and direct cost of available technologies produce nuanced results in the context of even the 0-month payback case. In the case of effectiveness changes, both sensitivity cases result in reductions to the volumetric fuel savings attributable to the proposal; lower effectiveness because the technologies applied in response to the standards save less fuel, and higher effectiveness because more of the increase in fuel economy occurs in the baseline. However, for both cases, social costs (a strong proxy for technology costs) move in the intuitive direction.

The cases that vary direct costs show volumetric fuel savings increasing under lower direct technology costs despite additional fuel economy improvements in the baseline, as more aggressive technology becomes cost effective. Higher direct costs lead to decreases in volumetric fuel savings, as more of the fuel economy improvement can be attributed to the rule. In both cases, social costs (as a result of technology costs) move in the intuitive direction.

If, instead of using the values in the main analysis, each sensitivity case were itself the main analysis, the costs and benefits attributable to the proposed rule would be as they appear in Table VI–32, below.

TABLE VI–32—COSTS AND BENEFITS OF PROPOSED STANDARDS FOR HD PICKUPS AND VANS UNDER ALTERNATIVE ASSUMPTIONS

Sensitivity case	Fuel savings (billion gallons)	CO2 reduction (MMT)	Fuel savings ($billion)	Social costs ($billion)	Social benefits ($billion)	Net social benefits ($billion)
6 Month Payback (main)	7.8	94.1	15.9	5.5	23.5	18.0
0 Month Payback	8.9	107.7	18.3	5.8	27.0	21.3
12 Month Payback	7.4	87.2	15.2	5.6	21.9	16.3
18 Month Payback	5.5	65.8	11.7	4.9	16.8	11.9
24 Month Payback	4.5	52.7	9.2	4.4	13.3	8.9
AEO-Low	8.1	94.7	11.5	5.1	17.8	12.7
AEO-High	7.3	84.9	19.6	5.8	27.4	21.6
AEO-Low, 0 Month Payback	9.3	109.1	13.3	5.6	20.6	15.1
AEO-High, 24 Month Payback	2.8	32.4	7.2	2.9	10.2	7.3
50pct Owner/operator Benefit	7.8	91.5	8.0	5.8	15.0	9.2
75pct Owner/operator Benefit	7.8	91.5	11.9	5.8	19.0	13.2
Low SCC	7.8	91.5	15.9	5.8	20.5	14.8
Low SCC, 0 Month Payback	8.9	104.7	18.3	6.1	23.6	17.5
High SCC	7.8	91.5	15.9	5.8	24.7	19.0
High SCC, 0 Month Payback	8.9	104.7	18.3	6.1	28.5	22.4
Very High SCC	7.8	91.5	15.9	5.8	29.5	23.8
Very High SCC, 0 Month Payback	8.9	104.7	18.3	6.1	34.0	27.9
05 Pct Rebound Effect	8.2	95.7	16.6	5.0	23.0	18.0
15 Pct Rebound Effect	7.5	87.2	15.2	6.5	22.9	16.4
20 Pct Rebound Effect	7.1	83.0	14.4	7.2	22.8	15.5
RPE-Based Markup	7.6	90.1	16.0	7.6	22.9	15.4
Mass Fatality Coeff 05pct	7.8	91.5	15.9	4.4	23.0	18.5
Mass Fatality Coeff 95pct	7.8	91.5	15.9	7.1	23.0	15.8
NoSHEVs	7.2	84.3	14.6	8.0	21.1	13.1
NoSHEVs, 0 Month Payback	7.0	82.0	14.3	4.4	20.6	16.2
Lower Effectiveness	7.9	94.0	16.7	6.8	23.9	17.1
Higher Effectiveness	7.5	88.0	15.3	10.1	22.1	12.0
Lower Direct Costs	7.7	90.5	15.8	5.2	22.8	17.6
Higher Direct Costs	7.8	91.5	8.5	3.8	13.8	10.0
Wider Diesel Downsizing	8.9	104.7	9.9	4.0	15.9	11.9
07 Pct Discount Rate	9.0	96.3	15.3	7.2	22.7	15.5
07 Pct DR, 0 Month Payback	10.3	112.2	18.2	8.5	26.9	18.4
Allow Gas To Diesel	7.9	92.3	16.0	5.9	23.1	17.2
Allow Gas To Diesel, 0 Month Payback	7.3	85.8	15.1	6.9	21.7	14.8
Flat mix after 2016	8.4	99.8	17.6	7.4	25.4	17.9

(7) Uncertainty Analysis

As in previous rules, NHTSA has conducted an uncertainty analysis to determine the extent to which uncertainty about input assumptions could impact the costs and benefits attributable to the proposed rule. Unlike the preceding sensitivity analysis, which is useful for understanding how alternative values of a single input assumption may influence the estimated impacts of the proposed standards, the uncertainty analysis considers multiple states of the world, characterized by a distribution of specific values of all relevant inputs, based on their relative probability of occurrence. A sensitivity analysis varies a single parameter of interest, holding all others constant at whatever nominal values are used to generate the single point estimate in the main analysis, and measures the resulting deviation. However, the uncertainty analysis allows all of those parameters to vary simultaneously—relaxing the assumption that ''all else is equal''.

Each trial, of which there are 14,000 in this analysis, represents a different state of the world in which the standards are implemented. To gauge the robustness of the estimates of impacts in the proposal, NHTSA varied technology costs and effectiveness, fuel prices, market demand for fuel economy improvements in the absence of the rule, the amount of additional driving associated with fuel economy improvements (the rebound effect), and the on-road gaps between realized fuel economy and laboratory test values for gasoline and diesel vehicles. The shapes and types of the probability distributions used in the analysis vary by uncertainty parameter, though the costs and effectiveness values for technologies are sampled as groups to minimize issues associated with interdependence. The most important input to the uncertainty analysis, fuel prices (which drive the majority of benefits from the proposed standards), are drawn from a range of fuel prices characterized by permutations of the Low, Reference, and High fuel price cases in the Annual Energy Outlook 2014.

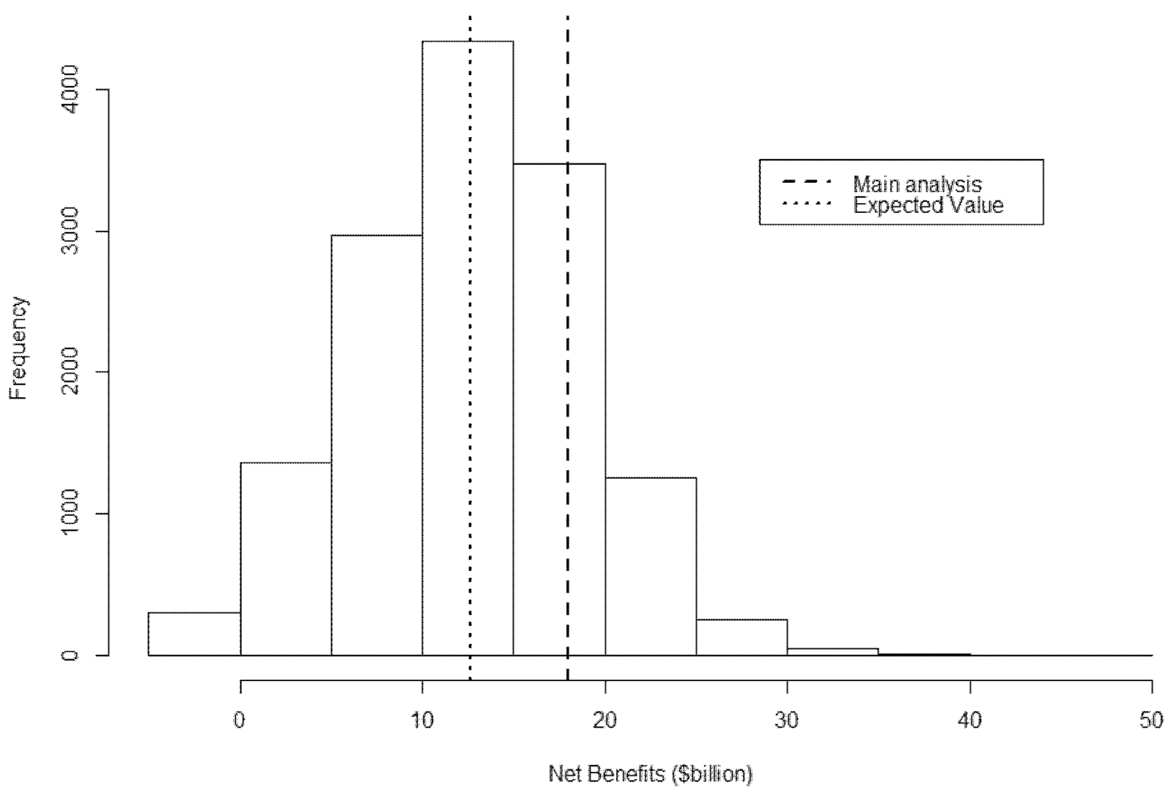

Figure VI-7 Distribution of Net Benefits from Proposed Standards for HD Pickups and Vans

Figure VI–7 displays the distribution of net benefits estimated by the ensemble of simulation runs. As Figure VI–7 indicates, the analysis produces a wide distribution of possible outcomes that are much broader than the range of estimates characterized by only the difference between the more and less dynamic baselines. While the expected value, the probability-weighted average outcome, is only about 70 percent of the net benefits estimated in the main analysis, almost all of the trials produce positive net benefits. In fact, the distribution suggests there is only a one percent chance of the proposal producing negative net benefits for HD pickups and vans. So while the estimated net benefits in the main analysis may be higher than the expected value when uncertainty is considered, net benefits at least as high as those estimated in the main analysis are still 20 times as likely as an outcome that results in net costs.

Figure VI–8 shows the distribution of payback periods (in years) for Model Year 2029 trucks across 14,000 simulation runs. The ''payback period'' typically refers to the number of years of vehicle use that occur before the savings on fuel expenditures offset the additional technology cost associated with improved fuel economy. As Figure VI–8 illustrates, the expected incremental technology cost of both Phase 1 and Phase 2 is eclipsed by the value of fuel savings by year three of ownership in most cases

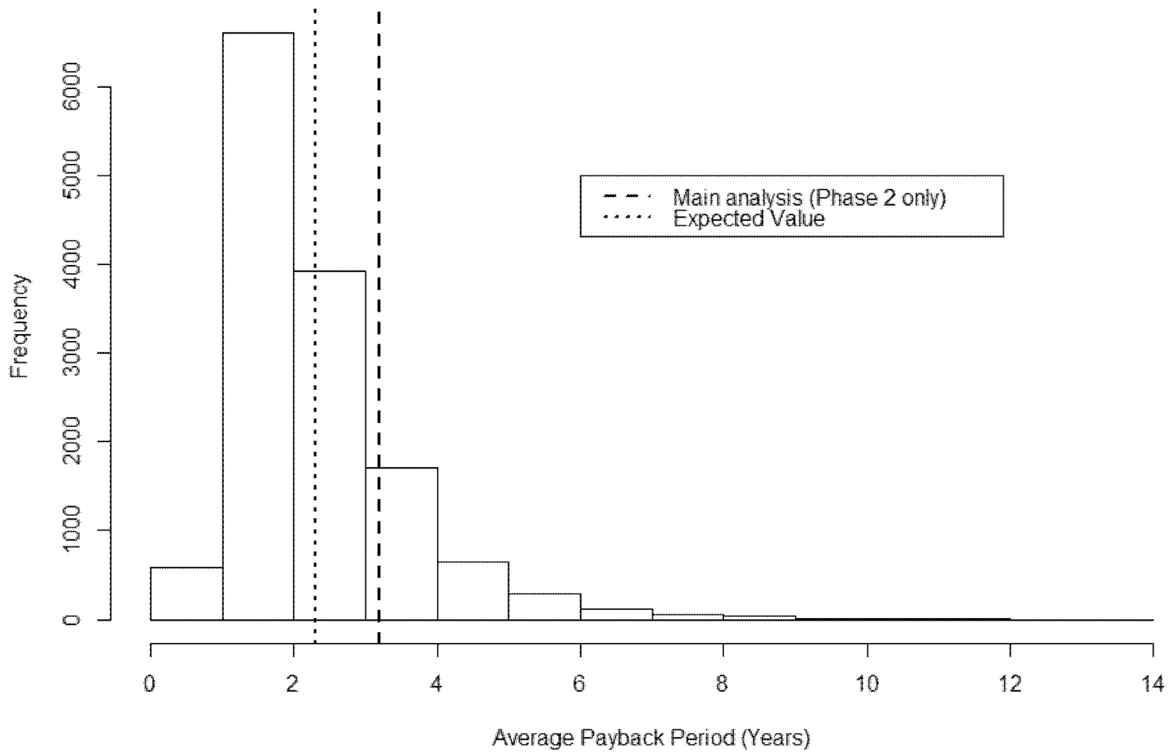

Figure VI-8 Average Payback Period for MY 2029 HP Pickup or Van Based on Expected Phase 1 and Phase 2 (combined) Technology Costs

This is an important metric for owner/operator acceptability and, though Figure VI–8 illustrates the long right tail of the payback distribution (where payback periods are likely to be unacceptably long), fewer than ten percent of the trials result in payback periods longer than four years. This suggests that, even in the face of uncertainty about future fuel prices and fuel economy in real-world driving conditions, buyers of the vehicles that are modified to comply with the requirements of the proposal will still see fuel savings greater than their additional vehicle cost in a relatively short period of time. As one would expect, the technologies used in Phase 1 of the MDHD program are likely to be more cost effective and serve to lower the expected payback period, even compared to the main analysis of Phase 2.

E. Compliance and Flexibility for HD Pickup and Van Standards

(1) Averaging, Banking, and Trading

The Phase 1 program established substantial flexibility in how manufacturers can choose to implement EPA and NHTSA standards while preserving the benefits for the environment and for energy consumption and security. Primary among these flexibilities are the gradual phase-in schedule, and the corporate fleet average approach which encompasses averaging, banking and trading described below. See Section IV.A. of the Phase 1 preamble (76 FR 57238) for additional discussion of the Phase 1 averaging, banking, and trading and Section IV.A (3) of the Phase 1 preamble (76 FR 57243) for a discussion of the credit calculation methodology.

Manufacturers in this category typically offer gasoline and diesel versions of HD pickup and van vehicle models. The agencies established chassis-based Phase 1 standards that are equivalent in terms of stringency for gasoline and diesel vehicles and are proposing the same approach to stringency for Phase 2. In Phase 1, the agencies established that HD pickups and vans are treated as one large averaging set that includes both gasoline and diesel vehicles [369] and the agencies are proposing to maintain this averaging set approach for Phase 2.

[369] See 40 CFR 1037.104(d) and the proposed 40 CFR 86.1819–14(d). Credits may not be transferred or traded between this vehicle averaging set and loose engines or other heavy-duty categories, as discussed in Section I.

As explained in Section II.C(3) of the Phase 1 preamble (76 FR 57167), and in Section VI.B (3) above, the program is structured so that final compliance is determined at the end of each model year, when production for the model year is complete. At that point, each manufacturer calculates production-weighted fleet average CO_2 emission and fuel consumption rates along with its production-weighted fleet average standard. Under this approach, a manufacturer's HD pickup and van fleet that achieves a fleet average CO_2 or fuel consumption level better than its standard would be allowed to generate credits. Conversely, if the fleet average CO_2 or fuel consumption level does not meet its standard, the fleet would incur debits (also referred to as a shortfall).

A manufacturer whose fleet generates credits in a given model year will have several options for using those credits to offset emissions from other HD pickups and vans. These options include credit carry-back, credit carry-forward, and credit trading within the HD pickup and van averaging set. These types of credit provisions also exist in the light-duty 2012–2016 and 2017–2025 MY vehicle rules, as well as many other mobile source standards issued by EPA under the CAA. The manufacturer will be able to carry back credits to offset a deficit that had accrued in a prior model year and was subsequently carried over to the current model year, with a limitation on the carry-back of credits to three model years. After satisfying any need to offset pre-existing deficits, a manufacturer may bank remaining credits for use in future years, with a limitation on the carry-forward of credits to five model years. Averaging vehicle credits with engine credits or between vehicle weight classes is not allowed, as discussed in Section I. The agencies are not proposing changes to any of these provisions for the Phase 2 program.

While the agencies are proposing to retain 5 year carry-forward of credits for all HD sectors, the agencies request comment on the merits of a temporary credit carry-forward period of longer than 5 years for HD pickups and vans, allowing Phase 1 credits generated in MYs 2014–2019 to be used through MY 2027. EPA included a similar provision in the MY 2017–2025 light-duty vehicle rule, which allows a one-time credit carry-forward of MY 2010–2015 credits to be carried forward through MY 2021.[370] Such a credit carry-forward extension for HD pickups and vans may provide manufacturers with additional flexibility during the transition to the proposed Phase 2 standards. A temporary credit carry-forward period of longer than five years for Phase 1 credits may help manufacturers resolve lead-time issues they might face as the proposed more stringent Phase 2 standards phase-in and help avoid negative impacts to their product redesign cycles which tend to be longer than those for light-duty vehicles.

As discussed in Section VI.B.4., EPA and NHTSA are proposing to change the HD pickup and van useful life for GHG emissions and fuel consumption from the current 11 years/120,000 miles to 15 years/150,000 miles to make the useful life for GHG emissions consistent with the useful life of criteria pollutants recently updated in the Tier 3 rule. As shown in the Equation VI–1 credits calculation formula below, established by the Phase 1 rule, useful life in miles is a multiplicative factor included in the calculation of CO_2 and fuel consumption credits. In order to ensure banked credits maintain their value in the transition from Phase 1 to Phase 2, NHTSA and EPA propose an adjustment factor of 1.25 (i.e, 150,000÷120,000) for credits that are carried forward from Phase 1 to the MY 2021 and later Phase 2 standards. Without this adjustment factor the proposed change in useful life would effectively result in a discount of banked credits that are carried forward from Phase 1 to Phase 2, which is not the intent of the change in the useful life. Consider, for example, a vehicle configuration with annual sales of 1,000 vehicles that was 10 g/mile below the standard. Under Phase 1, those vehicles would generate 1,200 Mg of credit (10×1,000×120,000÷1,000,000). Under Phase 2, the same vehicles would generate 1,500 Mg of credit (10×1,000×150,000÷1,000,000). The agencies do not believe that this proposed adjustment results in a loss of program benefits because there is little or no deterioration anticipated for CO_2 emissions and fuel consumption over the life of the vehicles. Also, as described in the standards and feasibility sections above, the carry-forward of credits is an integral part of the program, helping to smoothing the transition to the new Phase 2 standards. The agencies believe that effectively discounting carry-forward credits from Phase 1 to Phase 2 would be unnecessary and could negatively impact the feasibility of the proposed Phase 2 standards. EPA and NHTSA request comment on all aspects of the averaging, banking, and trading program.

Equation VI-1 Total Model Year Credit (Debit) Calculation

$$CO_2\text{ Credits (Mg)} = [(CO_2\text{ Std} - CO_2\text{ Act}) \times \text{Volume} \times \text{UL}] \div 1{,}000{,}000$$

$$\text{Fuel Consumption Credits (gallons)} = (\text{FC Std} - \text{FC Act}) \times \text{Volume} \times \text{UL} \times 100$$

Where:
CO_2 Std = Fleet average CO_2 standard (g/mi)
FC Std = Fleet average fuel consumption standard (gal/100 mile)
CO_2 Act = Fleet average actual CO_2 value (g/mi)
FC Act = Fleet average actual fuel consumption value (gal/100 mile)
Volume = the total production of vehicles in the regulatory category
UL = the useful life for the regulatory category (miles)

(2) Advanced Technology Credits

The Phase 1 program included on an interim basis advanced technology credits for MYs 2014 and later in the form of a multiplier of 1.5 for the following technologies:

- Hybrid powertrain designs that include energy storage systems
- Waste heat recovery
- All-electric vehicles
- Fuel cell vehicles

The advanced technology credit program is intended to encourage early development of technologies that are not yet commercially available. This multiplier approach means that each advanced technology vehicle would count as 1.5 vehicles in a manufacturer's compliance calculation. A manufacturer also has the option to subtract these vehicles out of its fleet and determine their performance as a separate fleet calculating advanced technology credits that can be used for all other HD vehicle categories, but these credits would, of course, not then be reflected in the manufacturer's conventional pickup and van category credit balance. The credits are thus 'special' in that they can be applied across the entire heavy-duty sector, unlike the ABT and early credits discussed above and the proposed off-cycle technology credits discussed in the following subsection. The agencies also capped the amount of advanced credits that can be transferred into any averaging set into any model year at 60,000 Mg to prevent market distortions.

The advanced technology multipliers were included on an interim basis in the Phase 1 program and the agencies are proposing to end the incentive multipliers beginning in MY 2021, when the more stringent Phase 2 standards are proposed to begin phase-in. The agencies are proposing a similar approach for the other HD sectors as

[370] 77 FR 62788, October 15, 2012.

discussed in Section I.C. (1). The advanced technology incentives are intended to promote the commercialization of technologies that have the potential to provide substantially better GHG emissions and fuel consumption if they were able to overcome major near-term market barriers. However, the incentives are not intended to be a permanent part of the program as they result in a decrease in overall GHG emissions and fuel consumption benefits associated with the program when used. More importantly, as explained in Section I. above, the agencies are already predicating the stringency of the proposed standards on development and deployment of two of these Phase 1 advanced technologies (waste heat recovery and strong hybrid technology), so that it would be inappropriate (and essentially a windfall) to include credits for use of these technologies in Phase 2.[371]

As discussed in Section I, the agencies request comment on the proposed approach for the advanced technology multipliers for HD pickups and vans as well as the other HD sectors, including comments on whether or not the credits should be extended to later model years for more advanced technologies such as EVs and fuel cell vehicles. These technologies are not projected to be part of the technology path used by manufacturer to meet the proposed Phase 2 standards for HD pickups and vans. Waste heat recovery is also not projected to be used for HD pickups and vans in the time frame of the proposed rules. EV and fuel cell technologies would presumably need to overcome the highest hurdles to commercialization for HD pickups and vans in the time frame of the proposed rules, and also have the potential to provide the highest level of benefit. We welcome comments on the need for such incentives, including information on why an incentive for specific technologies in this time frame may be warranted, recognizing that the incentive would result in reduced benefits in terms of CO_2 emissions and fuel use due to the Phase 2 program.

NHTSA and EPA established that for Phase 1, EVs and other zero tailpipe emission vehicles be factored into the fleet average GHG and fuel consumption calculations based on the diesel standards targets for their model year and work factor. The agencies also established for electric and zero emission vehicles that in the credits equation the actual emissions and fuel consumption performance be set to zero (*i.e.* that emissions be considered on a tailpipe basis exclusively) rather than including upstream emissions or energy consumption associated with electricity generation. As we look to the future, we are not projecting the adoption of electric HD pickups and vans into the market; therefore, we believe that this provision is still appropriate. Unlike the MY2012–2016 light-duty rule, which adopted a cap whereby upstream emissions would be counted after a certain volume of sales (see 75 FR 25434–25436), we believe there is no need to propose a cap for HD pickups and vans because of the infrequent projected use of EV technologies in the Phase 2 timeframe. In Phase 2, we propose to continue to deem electric vehicles as having zero CO_2, CH_4, and N_2O emissions as well as zero fuel consumption. We welcome comments on this approach. See also Section I for a discussion of the treatment of lifecycle emissions for alternative fuel vehicles and Section XI for the treatment of lifecycle emissions for natural gas specifically.

(3) Off-Cycle Technology Credits

The Phase 1 program established an opportunity for manufacturers to generate credits by applying innovative technologies whose CO_2 and fuel consumption benefits are not captured on the 2-cycle test procedure (*i.e.,* off-cycle).[372] As discussed in Sections III.F. and V.E.3., the agencies are proposing approaches for Phase 2 off-cycle technology credits for tractors and vocational vehicles with proposed provisions tailored for those sectors. For HD pickups and vans, the approach for off-cycle technologies established in Phase 1 is similar to that established for light-duty vehicles due to the use of the same basic chassis test procedures. The agencies are proposing to retain this approach for Phase 2. To generate credits, manufacturers are required to submit data and a methodology for determining the level of credits for the off-cycle technology subject to EPA and NHTSA review and approval. The application for off-cycle technology credits is also subject to a public evaluation process and comment period. EPA and NHTSA would approve the methodology and credits only if certain criteria were met. Baseline emissions and fuel consumption[373] and control emissions and fuel consumption need to be clearly demonstrated over a wide range of real world driving conditions and over a sufficient number of vehicles to address issues of uncertainty with the data. Data must be on a vehicle model-specific basis unless a manufacturer demonstrated model-specific data were not necessary. Once a complete application is submitted by the manufacturer, the regulations require that the agencies publish a notice of availability in the **Federal Register** notifying the public of a manufacturer's proposed off-cycle credit calculation methodology and provide opportunity for comment.

As noted above, the approach finalized for HD pickups and vans paralleled provisions for off-cycle credits in the MY 2012–2016 light-duty vehicle GHG program.[374] In the MY 2017–2025 light-duty vehicle program, EPA revised the off-cycle credits program for light-duty vehicles to streamline the credits process. In addition to the process established in the MY 2012–2016 rule, EPA added a list or ''menu'' of pre-approved off-cycle technologies and associated credit levels.[375] Manufacturers may use the pre-defined off-cycle technology menu to generate light-duty vehicle credits by demonstrating at time of certification that the vehicles are equipped with the technology without providing additional test data. Different levels of credits are provided for cars and light trucks in the light-duty program. NHTSA also included these credits in the CAFE program (in gallons/mile equivalent) starting with MY 2017. The list of pre-approved off-cycle technologies for light-duty vehicles is shown below.

[371] EPA and NHTSA similarly included temporary advanced technology multipliers in the light-duty 2017–2025 program, believing it was worthwhile to forego modest additional emissions reductions and fuel consumption improvements in the near-term in order to lay the foundation for the potential for much larger ''game-changing'' GHG and oil consumption reductions in the longer term. The incentives in the light-duty vehicle program are available through the 2021 model year. See 77 FR 62811, October 15, 2012.

[372] See 76 FR 57251, September 15, 2011, 40 CFR 1037.104(d)(13), and the proposed 40 CFR 86.1819–14(d)(13).

[373] Fuel consumption is derived from measured CO_2 emissions using conversion factors of 8,887 g CO_2/gallon for gasoline and 10,180 g CO_2/gallon for diesel fuel.

[374] See 75 FR 25440, May 7, 2010 and 40 CFR 86.1869–12(d).

[375] 77 FR 62832–62839, October 15, 2012.

TABLE VI–33—PRE-APPROVED OFF-CYCLE TECHNOLOGIES FOR LIGHT-DUTY VEHICLES

Pre-approved technologies
High Efficiency Exterior Lighting (at 100W)
Waste Heat Recovery (at 100W; scalable)
Solar Roof Panels (for 75 W, battery charging only)
Solar Roof Panels (for 75 W, active cabin ventilation plus battery charging)
Active Aerodynamic Improvements (scalable)
Engine Idle Start-Stop w/heater circulation system
Engine Idle Start-Stop without/heater circulation system
Active Transmission Warm-Up
Active Engine Warm-Up
Solar/Thermal Control

The agencies initially note that where vehicles are not chassis-certified, but rather evaluate compliance using the GEM simulation tool, with the proposed modifications to GEM, many more technologies (especially those related to engine and transmission improvements) will now be 'on-cycle'—evaluated directly by the GEM compliance tool. However, with respect to the proposed standards which would be chassis-certified—namely, the standards for heavy duty pickups and vans, the effectiveness of some technologies will be only partially captured (or not captured at all). EPA and NHTSA are requesting comment on establishing a pre-defined technology menu list for HD pickups and vans. The list for HD pickups and vans could include some or all of the technologies listed in Table VI–33. As with the light-duty program, the pre-defined list may simplify the process for generating off-cycle credits and may further encourage the introduction of these technologies. However, the appropriate default level of credits for the heavier vehicles would need to be established. The agencies request comments with supporting HD pickup and van specific data and analysis that would provide a substantive basis for appropriate adjustments to the credits levels for the HD pickup and van category. The data and analysis would need to demonstrate that the pre-defined credit level represents real-world emissions reductions and fuel consumption improvements not captured by the 2-cycle test procedures.

As with the light-duty vehicle program, the agencies would also consider including a cap on credits generated from a pre-defined list established for HD pickups and vans. The cap for the light-duty vehicle program is 10 g/mile (and gallons/mi equivalent) applied on a manufacturer fleet-wide basis.[376] The 10 g/mile cap limits the total off-cycle credits allowed based on the pre-defined list across the manufacturer's light-duty vehicle fleet. The agencies adopted the cap on credits to address issues of uncertainty regarding the level of credits automatically assigned to each technology. Manufacturers able to demonstrate that a technology provides improvements beyond the menu credit level would be able to apply for additional credits through the individual demonstration process noted above. Credits based on the individual manufacturer demonstration would not count against the credit cap. If a menu list of credits is developed to be included in the HD pickup and van program, a cap may also be appropriate depending on the technology list and credit levels. The agencies request comments on all aspects of the off-cycle credits program for HD trucks and vans.

(4) Demonstrating Compliance for Heavy-Duty Pickup Trucks and Vans

The Phase 1 rule established a comprehensive compliance program for HD pickups and vans that NHTSA and EPA are generally retaining for Phase 2. The compliance provisions cover details regarding the implementation of the fleet average standards including vehicle certification, demonstrating compliance at the end of the model year, in-use standards and testing, carryover of certification test data, and reporting requirements. Please see Section V.B (1) of the Phase 1 rule preamble (76 FR 57256–57263) for a detailed discussion of these provisions.

The Phase 1 rule contains special provisions regarding loose engines and optional chassis certification of certain vocational vehicles over 14,000 lbs. GVWR. The agencies are proposing to extend the optional chassis certification provisions to Phase 2 and are not proposing to extend the loose engine provisions. See the vocational vehicle Section V.E. and XIV.A.2 for a detailed discussion of the proposal for optional chassis certification and II.D. for the discussion of loose engines.

VII. Aggregate GHG, Fuel Consumption, and Climate Impacts

Given that the purpose of setting these Phase 2 standards is to reduce fuel consumption and greenhouse gas (GHG) emissions from heavy-duty vehicles, it is necessary for the agencies to analyze the extent to which the proposed standards would accomplish that purpose. This section describes the agencies' methodologies for projecting the reductions in greenhouse gas (GHG) emissions and fuel consumption, and the methodologies the agencies used to quantify the impacts associated with the proposed standards, as well as the impacts of Alternative 4. In addition, EPA's analyses of the projected change in atmospheric carbon dioxide (CO_2) concentration and consequent climate change impacts are discussed. Because of NHTSA's obligations under EPCA/EISA and NEPA, NHTSA further analyzes, for each regulatory alternative, the projected environmental impacts related to fuel consumption, GHG emissions, and climate change. Detailed documentation of this analysis is provided in Chapters 3 and 5 of NHTSA's DEIS accompanying today's notice.

A. What methodologies did the agencies use to project GHG emissions and fuel consumption impacts?

Different tools exist for estimating potential fuel consumption and GHG emissions impacts associated with fuel efficiency and GHG emission standards. One such tool is EPA's official mobile source emissions inventory model named Motor Vehicle Emissions Simulator (MOVES).[377] The agencies used the most current version of the model, MOVES2014, to quantify the impacts of the proposed standards for vocational vehicles and combination tractor-trailers on GHG emissions and fuel consumption for each regulatory alternative. MOVES was run with user

[376] See 40 CFR 86.1869–12(b).

[377] MOVES homepage: *http://www.epa.gov/otaq/models/moves/index.htm* (last accessed Feb 23, 2015).

input databases, described in more detail below, that reflected the projected technological improvements resulting from the proposed rules, such as the improvements in engine and vehicle efficiency, aerodynamic drag, and tire rolling resistance.

Another such tool is DOT's CAFE model, which estimates how manufacturers could potentially apply technology improvements in response to new standards, and then calculates, among other things, resultant changes in national fuel consumption and GHG emissions. For today's analysis of potential new standards for HD pickups and vans, the model was reconfigured to use the work-based attribute metric of ''work factor'' established in the Phase 1 rule for heavy-duty pickups and vans instead of the light-duty ''footprint'' attribute metric. The CAFE model takes user-specified inputs on, among other things, vehicles that will be produced in a given model year, technologies available to improve fuel efficiency on those vehicles, potential regulatory standards that would drive improvements in fuel efficiency, and economic assumptions. The CAFE model takes every vehicle in each manufacturer's fleet and decides what technologies to add to those vehicles in order to allow each manufacturer to comply with the standards in the most cost-effective way. Based on the resulting improved vehicle fleet, the CAFE model then calculates total fuel consumption and GHG emissions impacts based on those inputs, along with economic costs and benefits. The DOT's CAFE model is further described in detail in Section VI.C of the preamble and Chapter 2 of the draft RIA.

For these rules, the agencies conducted coordinated and complementary analyses by using two analytical methods for the heavy-duty pickup and van segment employing both DOT's CAFE model and EPA's MOVES model. The agencies used EPA's MOVES model to estimate fuel consumption and emissions impacts for tractor-trailers (including the engine that powers the tractor), and vocational vehicles (including the engine that powers the vehicle).

For heavy-duty pickups and vans, the agencies performed complementary analyses, which we refer to as ''Method A'' and ''Method B''. In Method A, the CAFE model was used to project a pathway the industry could use to comply with each regulatory alternative and the estimated effects on fuel consumption, emissions, benefits and costs. In Method B, the MOVES model was used to estimate fuel consumption and emissions from these vehicles. NHTSA considered Method A as its central analysis. EPA considered the results of both methods. The agencies concluded that both methods led the agencies to the same conclusions and the same selection of the proposed standards. See Chapter 5 of the draft RIA for additional discussions of these two methods.

For both methods, the agencies analyzed the impact of the proposed rules and Alternative 4, relative to two different reference cases—less dynamic and more dynamic. The less dynamic baseline projects very little improvement in new vehicles in the absence of new Phase 2 standards. In contrast, the more dynamic baseline projects more improvements in vehicle fuel efficiency. The agencies considered both reference cases (for additional details, see Chapter 11 of the draft RIA). The results for all of the regulatory alternatives relative to both reference cases, derived via the same methodologies discussed in this section, are presented in Section X of the preamble.

For brevity, a subset of these analyses are presented in this section, and the reader is referred to both the RIA Chapter 11 and NHTSA's DEIS Chapters 3 and 5 for complete sets of these analyses. In this section, Method A is presented for both the proposed standards (*i.e.,* Alternative 3—the agencies' preferred alternative) and for the standards the agencies considered in Alternative 4, relative to both the more dynamic baseline (Alternative 1b) and the less dynamic baseline (Alternative 1a). Method B is presented also for the proposed standards and Alternative 4, but relative only to the less dynamic baseline. The agencies' intention for presenting both of these complementary and coordinated analyses is to offer interested readers the opportunity to compare the regulatory alternatives considered for Phase 2 in both the context of our HD Phase 1 analytical approaches and our light-duty vehicle analytical approaches. The agencies view these analyses as corroborative and reinforcing: Both support agencies' conclusion that the proposed standards are appropriate and at the maximum feasible levels.

Because reducing fuel consumption also affects emissions that occur as a result of fuel production and distribution (including renewable fuels), the agencies also calculated those ''upstream'' changes using the ''downstream'' fuel consumption reductions predicted by the CAFE model and the MOVES model. As described in Section VI, Method A uses the CAFE model to estimate vehicular fuel consumption and emissions impacts for HD pickups and vans and to calculate upstream impacts. For vocational vehicles and combination tractor-trailers, both Method A and Method B use the same upstream tools originally created for the Renewable Fuel Standard 2 (RFS2) rulemaking analysis,[378] used in the LD GHG rulemakings,[379] HD GHG Phase 1,[380] and updated for the current analysis. The estimate of emissions associated with production and distribution of gasoline and diesel from crude oil is based on emission factors in the ''Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation'' model (GREET) developed by DOE's Argonne National Lab. In some cases, the GREET values were modified or updated by the agencies to be consistent with the National Emission Inventory (NEI) and emission factors from MOVES. Method B uses the same tool described above to estimate the upstream impacts for HD pickups and vans. For additional details, see Chapter 5 of the draft RIA. The upstream tool used for the Method B can be found in the docket.[381] As noted in Section VI above, these analyses corroborate each other's results.

The agencies analyzed the anticipated emissions impacts of the proposed rules and Alternative 4 on carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFCs) for a number of calendar years (for purposes of the discussion in these proposed rules, only 2025, 2035 and 2050 will be shown) by comparing to both reference cases.[382] Additional runs were performed for just the three of the greenhouse gases (CO_2, CH_4, and N_2O) and for fuel consumption for every calendar year from 2014 to 2050, inclusive, which fed the economy-wide modeling, monetized greenhouse gas benefits estimation, and climate impacts

[378] U.S. EPA. Draft Regulatory Impact Analysis: Changes to Renewable Fuel Standard Program. Chapters 2 and 3. May 26, 2009. Docket ID: EPA–HQ–OAR–2009–0472–0119

[379] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards (77 FR 62623, October 15, 2012).

[380] Greenhouse Gas Emission Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (76 FR 57106, September 15, 2011).

[381] Memorandum to the Docket ''Upstream Emissions Modeling Files for HDGHG Phase 2 NPRM'' Docket No. EPA–HQ–OAR–2014–0827.

[382] The emissions impacts of the proposed rules on non-GHGs, including air toxics, were also estimated using MOVES. See Section VIII of the preamble for more information.

analyses, discussed in sections below.[383]

B. Analysis of Fuel Consumption and GHG Emissions Impacts Resulting From Proposed Standards and Alternative 4

The following sections describe the model inputs and assumptions for both the less dynamic and more dynamic reference cases and the control case representing the agencies' proposed fuel efficiency and GHG standards. The agencies request comment on the model inputs, projected reductions in energy rates and fuel consumption rates presented in this section, as well as in Chapter 5 of the draft RIA. The details of all the MOVES runs, and input data tables, as well as the MOVES code and database, can be found in the docket.[384] See Section VI.C for the discussion of the model inputs and assumptions for the analysis of the HD pickups and vans using DOT's CAFE Model.

(1) Model Inputs and Assumptions for the Less Dynamic Reference Case

The less dynamic reference case (identified as Alternative 1a in Section X), includes the impact of Phase 1, but generally assumes that fuel efficiency and GHG emission standards are not improved beyond the required 2018 model year levels. Alternative 1a functions as one of the baselines against which the impacts of the proposed standards can be evaluated. This case projects some improvements in the efficiency of the box trailers pulled by combination tractors due to increased penetration of aerodynamic technologies and low rolling resistance tires attributed to both EPA's SmartWay Transport Partnership and California Air Resources Board's Tractor-Trailer Greenhouse Gas regulation, as described in Section IV of the preamble. For other HD vehicle sectors, no market-driven improvement in fuel efficiency was assumed. For HD pickups and vans, the CAFE model was applied in a manner that assumes manufacturers would only add fuel-saving technology as needed to continue complying with Phase 1 standards. MOVES2014 defaults were used for all other parameters to estimate the emissions inventories for this case. The less dynamic reference case assumed the MOVES2014 default vehicle population and miles traveled estimates. The growth in vehicle populations and miles traveled in MOVES2014 is based on the relative annual VMT growth from AEO2014 Early Release for model years 2012 and later.[385]

(2) Model Inputs and Assumptions for the More Dynamic Reference Case

The more dynamic reference case (identified as Alternative 1b in Section X), also includes the impact of Phase 1 and generally assumes that fuel efficiency and GHG emission standards are not improved beyond the required 2018 model year levels. However, for this case, the agencies assume market forces would lead to additional fuel efficiency improvements for HD pickups and vans and tractor-trailers. These additional assumed improvements are described in Section X of the preamble. No additional fuel efficiency improvements due to market forces were assumed for vocational vehicles. For HD pickups and vans, the agencies applied the CAFE model using the input assumption that manufacturers having achieved compliance with Phase 1 standards would continue to apply technologies for which increased purchase costs would be ''paid back'' through corresponding fuel savings within the first six months of vehicle operation. The agencies conducted the MOVES analysis of this case in the same manner as for the less dynamic reference case.

(3) Model Inputs and Assumptions for ''Control'' Case

(a) Vocational Vehicles and Tractor-Trailers

The ''control'' case represents the agencies' proposed fuel efficiency and GHG standards. The agencies developed additional user input data for MOVES runs to estimate the control case inventories. The inputs to MOVES for the control case account for improvements of engine and vehicle efficiency in vocational vehicles and combination tractor-trailers. The agencies used the percent reduction in aerodynamic drag and tire rolling resistance coefficients and absolute changes in average total running weight (gross combined weight) expected from the proposed rules to develop the road load inputs for the control case, based on the GEM analysis. The agencies also used the percent reduction in CO_2 emissions expected from the powertrain and other vehicle technologies not accounted for in the aerodynamic drag and tire rolling resistance in the proposed rules to develop energy inputs for the control case runs.

Table VII–1 and Table VII–2 describe the proposed improvements in engine and vehicle efficiency from the proposed rules for vocational vehicles and combination tractor-trailers that were input into MOVES for estimating the control case emissions inventories. Additional details regarding the MOVES inputs are included in the Chapter 5 of the draft RIA.

TABLE VII–1—ESTIMATED REDUCTIONS IN ENERGY RATES FOR THE PROPOSED STANDARDS

Vehicle type	Fuel	Model years	Reduction from reference case (percent)
Long-haul Tractor-Trailers and HHD Vocational	Diesel	2018–2020	1.3
		2021–2023	5.2
		2024–2026	9.7
		2027+	10.4
Short-haul Tractor-Trailers and HHD Vocational	Diesel	2018–2020	0.9

[383] The CAFE model estimates, among other things, manufacturers' potential multiyear planning decisions within the context of an estimated year-by-year product cadence (*i.e.,* schedule for redesigning and freshening vehicles). The agencies included earlier model years in the analysis in order to account for the potential that manufacturers might take anticipatory actions in model years preceding those covered by today's proposal.

[384] Memorandum to the Docket ''Runspecs, Model Inputs, MOVES Code and Database for HD GHG Phase 2 NPRM Emissions Modeling'' Docket No. EPA–HQ–OAR–2014–0827

[385] MOVES2014 assumes the population and VMT growth based on the early release version of AEO2014 because it was the only version that was available at the time of MOVES2014 development. Annual Energy Outlook 2014. *http://www.eia.gov/forecasts/aeo/er/* (last accessed Feb 23, 2015).

[386] Vocational vehicles modeled in MOVES include heavy heavy-duty, medium heavy-duty, and light heavy-duty vehicles. However, for light heavy-duty vocational vehicles, class 2b and 3 vehicles are not included in the inventories for the vocational sector. Instead, all vocational vehicles with GVWR of less than 14,000 lbs were modeled using the energy rate reductions described below for HD pickup trucks and vans. In practice, many manufacturers of these vehicles choose to average the lightest vocational vehicles into chassis-certified families (*i.e.,* heavy-duty pickups and vans).

TABLE VII–1—ESTIMATED REDUCTIONS IN ENERGY RATES FOR THE PROPOSED STANDARDS—Continued

Vehicle type	Fuel	Model years	Reduction from reference case (percent)
		2021–2023	5.0
		2024–2026	9.5
		2027+	10.4
Single-Frame Vocational[386]	Diesel and CNG	2021–2023	5.3
		2024–2026	8.9
		2027+	13.3
	Gasoline	2021–2023	3.3
		2024–2026	5.4
		2027+	10.3

TABLE VII–2—ESTIMATED REDUCTIONS IN ROAD LOAD FACTORS FOR THE PROPOSED STANDARDS

Vehicle type	Model years	Reduction in tire rolling resistance coefficient (percent)	Reduction in aerodynamic drag coefficient (percent)	Weight reduction (LB)[a]
Combination Long-haul Tractor-Trailers	2018–2020	5.5	5.1	−131
	2021–2023	9.8	15.3	−199
	2024–2026	15.7	20.5	−246
	2027+	17.9	26.9	−304
Combination Short-haul Tractor-Trailers[387]	2018–2020	4.0	1.6	−41
	2021–2023	10.5	9.3	−79
	2024–2026	13.9	12.3	−100
	2027+	17.6	15.9	−127
Intercity Buses	2021–2023	6.5	0	0
	2024–2026	9.2	0	0
	2027+	16.5	0	0
Transit Buses	2021–2023	0	0	0
	2024–2026	2.9	0	0
	2027+	3.0	0	0
School Buses	2021–2023	0	0	0
	2024–2026	2.9	0	0
	2027+	4.0	0	0
Refuse Trucks	2021–2023	0	0	20
	2024–2026	2.9	0	20
	2027+	3.0	0	25
Single Unit Short-haul Trucks	2021–2023	4.8	0	5.8
	2024–2026	8.3	0	5.8
	2027+	13.0	0	7
Single Unit Long-haul Trucks	2021–2023	6.5	0	20
	2024–2026	9.2	0	20
	2027+	16.5	0	25
Motor Homes	2021–2023	3.0	0	0
	2024–2026	6.2	0	0
	2027+	7.4	0	0

Note:
[a] Negative weight reductions reflect an expected weight increase as a byproduct of other vehicle and engine improvements, as described in Chapter 5 of the draft RIA.

In addition, the proposed CO_2 standard for tractors reflecting the use of auxiliary power units (APU) during extended idling, as discussed in Section III.D of the preamble, was included in the modeling for the long-haul combination tractor-trailers, as shown below in Table VII–3.

TABLE VII–3—ASSUMED APU USE DURING EXTENDED IDLING FOR COMBINATION LONG-HAUL TRACTOR-TRAILERS

Vehicle type	Model year	APU penetration[a] (percent)
Combination Long-Haul Trucks	2010–2020	30
	2021–2023	80

[387] Vocational tractors are included in the short-haul tractor segment.

TABLE VII–3—ASSUMED APU USE DURING EXTENDED IDLING FOR COMBINATION LONG-HAUL TRACTOR-TRAILERS—Continued

Vehicle type	Model year	APU penetration [a] (percent)
	2024+	90

Note:
[a] The assumed APU penetration remains constant for model years 2024 and later.

To account for the potential increase in vehicle use expected to result from improvements in fuel efficiency for vocational vehicles and combination tractor-trailers due to the proposed rules (also known as the ''rebound effect'' and described in more detail in Chapter 5 of the draft RIA), the control case assumed an increase in VMT from the reference levels by 1.83 percent for the vocational vehicles and 0.79 percent for the combination tractor-trailers.

(b) Heavy-Duty Pickups and Vans

As explained above and as also discussed in the draft RIA, the agencies used both DOT's CAFE model and EPA's MOVES model, for Method A and B, respectively, to project fuel consumption and GHG emissions impacts resulting from the proposed standards for HD pickups and vans, including downstream vehicular emissions as well as emissions from upstream processes related to fuel production, distribution, and delivery.

(i) Method A for HD Pickups and Vans

For Method A, the agencies used the CAFE model which applies fuel properties (density and carbon content) to estimated fuel consumption in order to calculate vehicular CO_2 emissions, applies per-mile emission factors from MOVES to estimated VMT (for each regulatory alternative, adjusted to account for the rebound effect) in order to calculate vehicular CH_4 and N_2O emissions (as well, as discussed below, of non-GHG pollutants), and applies per-gallon upstream emission factors from GREET in order to calculate upstream GHG (and non-GHG) emissions.

As discussed above in Section VI, the proposed standards for HD pickups and vans—that is, the functions defining fuel consumption and GHG targets that each depend work factor—increase in stringency by 2.5 percent annually during model years 2021–2027. The standards define targets specific to each vehicle model, but no vehicle is required to meet its target; instead, the production-weighted averages of the vehicle-specific targets define average fuel consumption and CO_2 emission rates that a given manufacturer's overall fleet of produced vehicles is required to achieve. The standards are specified separately for gasoline and diesel vehicles, and vary with work factor. Work factors could change, and today's analysis assumes that some applications of mass reduction could enable increased work factor in cases where manufacturers could increase a vehicle's rated payload and/or towing capacity. Therefore, average required levels will depend on the mix of vehicles and work factors of the vehicles produced for sale in the U.S., and since these can only be estimated at this time, average required and achieved fuel consumption and CO_2 emission rates are subject to uncertainty. Between today's notice and issuance of the ensuing final rule, the agencies intend to update the market forecast (and other inputs) used to analyze HD pickup and van standards, and expect that doing so will lead to different estimates of required and achieved fuel consumption and CO_2 emission rates (as well as different estimates of impacts, costs, and benefits).

The following four tables present stringency increases and estimated required and achieved fuel consumption and CO_2 emission rates for the two No Action Alternatives (Alternative 1a and 1b) and the proposed standards defining the Preferred Alternative. Stringency increases are shown relative to standards applicable in model year 2018 (and through model year 2020). As mathematical functions, the standards themselves are not subject to uncertainty. By 2027, they are 16.2 percent more stringent (*i.e.,* lower) than those applicable during 2018–2020. NHTSA estimates that, by model 2027, the proposed standards could reduce average required fuel consumption and CO_2 emission rates to about 4.86 gallons/100 miles and about 458 grams/mile, respectively. NHTSA further estimates that average achieved fuel consumption and CO_2 emission rates could correspondingly be reduced to about the same levels. If, as represented by Alternative 1b, manufacturers would, even absent today's proposed standards, voluntarily make improvements that pay back within six months, these model year 2027 levels are about 13.5 percent lower than the agencies estimate could be achieved under the Phase 1 standards defining the No Action Alternative. If, as represented by Alternative 1a, manufacturers would, absent today's proposed standards, only apply technology as required to achieve compliance, these model year 2027 levels are about 15 percent lower than the agencies estimate could be achieved under the Phase 1 standards. As indicated below, the agencies estimate that these improvements in fuel consumption and CO_2 emission rates would build from model year to model year, beginning as soon as model year 2017 (insofar as manufacturers may make anticipatory improvements if warranted given planned produce cadence).

TABLE VII–4—STRINGENCY OF HD PICKUP AND VAN STANDARDS, ESTIMATED AVERAGE REQUIRED AND ACHIEVED FUEL CONSUMPTION RATES FOR METHOD A, RELATIVE TO ALTERNATIVE 1b [a]

Model year	Stringency (vs. 2018) (%)	Ave. required fuel cons. (gal./100 mi.)			Ave. achieved fuel cons. (gal./100 mi.)		
		No action	Proposed	Reduction (%)	No action	Proposed	Reduction (%)
2014	MYs 2014–2020 Subject to Phase 1 Standards.	6.41	6.41	0.0	6.21	6.21	0.0
2015		6.41	6.41	0.0	6.12	6.12	0.0
2016		6.27	6.27	0.0	6.15	6.15	0.0
2017		6.11	6.11	0.0	5.89	5.88	0.2
2018		5.80	5.80	0.0	5.75	5.70	0.8
2019		5.78	5.78	0.0	5.72	5.68	0.7
2020		5.78	5.78	0.0	5.69	5.64	0.8
2021	2.5	5.77	5.64	2.2	5.63	5.42	3.8
2022	4.9	5.77	5.50	4.7	5.63	5.42	3.8
2023	7.3	5.77	5.38	6.8	5.63	5.28	6.3
2024	9.6	5.77	5.25	9.0	5.63	5.23	7.1
2025	11.9	5.77	5.12	11.4	5.63	4.99	11.5
2026	14.1	5.77	4.98	13.7	5.63	4.93	12.5
2027	16.2	5.77	4.86	15.8	5.62	4.86	13.7
2028*	16.2	5.77	4.86	15.8	5.62	4.86	13.7
2029*	16.2	5.77	4.86	15.8	5.62	4.85	13.7
2030*	16.2	5.77	4.86	15.8	5.62	4.85	13.7

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.
*Absent further action, standards assumed to continue unchanged after model year 2027.

TABLE VII–5—STRINGENCY OF HD PICKUP AND VAN STANDARDS, ESTIMATED AVERAGE REQUIRED AND ACHIEVED CO_2 EMISSION RATES FOR METHOD A, RELATIVE TO ALTERNATIVE 1B [A]

Model year	Stringency (vs. 2018) (%)	Ave. required CO_2 Rate (g./mi.)		Ave. achieved CO_2 Rate (g./mi.)			
		No action	Proposed	Reduction	No Action	Proposed	Reduction (%)
2014	MYs 2014–2020 Subject to Phase 1 Standards.	602	602	0.0	581	581	0.0
2015		608	608	0.0	578	578	0.0
2016		593	593	0.0	580	580	0.0
2017		578	578	0.0	556	554	0.2
2018		548	548	0.0	543	538	0.8
2019		545	545	0.0	539	535	0.7
2020		545	545	0.0	536	532	0.8
2021	2.5	544	532	2.2	530	510	3.8
2022	4.9	544	519	4.7	530	510	3.8
2023	7.3	544	507	6.8	530	496	6.4
2024	9.6	544	495	9.1	530	492	7.2
2025	11.9	544	482	11.3	530	470	11.3
2026	14.1	544	470	13.6	530	465	12.3
2027	16.2	544	458	15.8	529	458	13.4
2028*	16.2	544	458	15.8	529	458	13.4
2029*	16.2	544	458	15.8	529	458	13.5
2030*	16.2	544	458	15.8	529	458	13.5

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.
*Absent further action, standards assumed to continue unchanged after model year 2027.

TABLE VII–6—STRINGENCY OF HD PICKUP AND VAN STANDARDS, ESTIMATED AVERAGE REQUIRED AND ACHIEVED FUEL CONSUMPTION RATES FOR METHOD A, RELATIVE TO ALTERNATIVE 1a [a]

Model year	Stringency (vs. 2018)(%)	Ave. required fuel cons. (gal./100 mi.)			Ave. achieved fuel cons. (gal./100 mi.)		
		No action	Proposed	Reduction (%)	No Action	Proposed	Reduction (%)
2014	MYs 2014–2020 Subject to Phase 1 Standards.	6.41	6.41	0.0	6.21	6.21	0.0
2015		6.41	6.41	0.0	6.12	6.12	0.0
2016		6.27	6.27	0.0	6.15	6.15	0.0
2017		6.11	6.11	0.0	5.89	5.87	0.3
2018		5.80	5.80	**^0.0	5.75	5.70	0.9
2019		5.78	5.78	0.0	5.73	5.68	0.8
2020		5.78	5.78	0.0	5.73	5.68	0.8
2021	2.5	5.77	5.64	2.3	5.72	5.44	4.8
2022	4.9	5.77	5.50	4.7	5.72	5.44	4.8
2023	7.3	5.77	5.38	6.8	5.72	5.29	7.6

TABLE VII–6—STRINGENCY OF HD PICKUP AND VAN STANDARDS, ESTIMATED AVERAGE REQUIRED AND ACHIEVED FUEL CONSUMPTION RATES FOR METHOD A, RELATIVE TO ALTERNATIVE 1a [a]—Continued

Model year	Stringency (vs. 2018)(%)	Ave. required fuel cons. (gal./100 mi.)			Ave. achieved fuel cons. (gal./100 mi.)		
		No action	Proposed	Reduction (%)	No Action	Proposed	Reduction (%)
2024	9.6	5.77	5.25	9.1	5.72	5.23	8.5
2025	11.9	5.77	5.12	11.4	5.72	4.98	12.9
2026	14.1	5.77	4.98	13.7	5.72	4.94	13.6
2027	16.2	5.77	4.86	15.8	5.72	4.87	14.9
2028*	16.2	5.77	4.86	15.8	5.72	4.87	14.9
2029*	16.2	5.77	4.86	15.8	5.72	4.86	15.0
2030*	16.2	5.77	4.86	15.8	5.72	4.86	15.0

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.
*Absent further action, standards assumed to continue unchanged after model year 2027.
**Increased work factor for some vehicles produces a slight increase in average required fuel consumption.

TABLE VII–7—STRINGENCY OF HD PICKUP AND VAN STANDARDS, ESTIMATED AVERAGE REQUIRED AND ACHIEVED CO_2 EMISSION RATES FOR METHOD A, RELATIVE TO ALTERNATIVE 1A [A]

Model year	Stringency (vs. 2018) (%)	Ave. required CO_2 Rate (g./mi.)			Ave. achieved CO_2 Rate (g./mi.)		
		No action	Proposed	Reduction (%)	No action	Proposed	Reduction (%)
2014	MYs 2014–2020 Subject to Phase 1 Standards.	6.02	602	0.0	581	581	0.0
2015		6.08	608	0.0	578	578	0.0
2016		593	593	0.0	580	580	0.0
2017		578	578	0.0	556	554	0.3
2018		548	548	** −0.0	543	538	0.9
2019		545	546	** −0.1	539	535	0.8
2020		545	545	** −0.1	539	535	0.8
2021	2.5	544	532	2.2	538	512	4.9
2022	4.9	544	519	4.7	538	512	4.9
2023	7.3	544	507	6.8	538	497	7.7
2024	9.6	544	495	9.1	538	492	8.6
2025	11.9	544	482	11.4	538	470	12.7
2026	14.1	544	470	13.6	538	466	13.4
2027	16.2	544	458	15.8	538	459	14.7
2028*	16.2	544	458	15.8	538	459	14.7
2029*	16.2	544	458	15.8	538	459	14.8
2030*	16.2	544	458	15.8	538	459	14.8

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.
*Absent further action, standards assumed to continue unchanged after model year 2027.
**Increased work factor for some vehicles produces a slight increase in the average required CO_2 emission rate.

While the above tables show the agencies' estimates of average fuel consumption and CO_2 emission rates manufacturers might achieve under today's proposed standards, total U.S. fuel consumption and GHG emissions from HD pickups and vans will also depend on how many of these vehicles are produced, and how they are operated over their useful lives. Relevant to estimating these outcomes, the CAFE model applies vintage-specific estimates of vehicle survival and mileage accumulation, and adjusts the latter to account for the rebound effect. This impact of the rebound effect is specific to each model year (and, underlying, to each vehicle model in each model year), varying with changes in achieved fuel consumption rates.

(ii) Method B for HD Pickups and Vans

For Method B, the MOVES model was used to estimate fuel consumption and GHG emissions for HD pickups and vans. MOVES evaluated the proposed standards for HD pickup trucks and vans in terms of grams of CO_2 per mile or gallons of fuel per 100 miles. Since nearly all HD pickup trucks and vans are certified on a chassis dynamometer, the CO_2 reductions for these vehicles were not represented as engine and road load reduction components, but rather as total vehicle CO_2 reductions. The control case for HD pickups and vans assumed an increase in VMT from the reference levels by 1.18 percent for HD pickups and vans.

TABLE VII–8—ESTIMATED TOTAL VEHICLE CO_2 REDUCTIONS FOR THE PROPOSED STANDARDS AND IN-USE EMISSIONS FOR HD PICKUP TRUCKS AND VANS IN METHOD B[a]

Vehicle type	Fuel	Model year	CO_2 reduction from reference case (%)
HD pickup trucks and vans	Gasoline and Diesel	2021	2.50
		2022	4.94
		2023	7.31
		2024	9.63
		2025	11.89
		2026	14.09
		2027+	16.24

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

C. What are the projected reductions in fuel consumption and GHG emissions?

NHTSA and EPA expect significant reductions in GHG emissions and fuel consumption from the proposed rules—fuel consumption reductions from more efficient vehicles, emission reductions from both downstream (tailpipe) and upstream (fuel production and distribution) sources, and HFC emissions from the proposed air conditioning leakage standards. The following subsections summarize two slightly different analyses of the annual GHG emissions and fuel consumption reductions expected from these proposed rules, as well as the reductions in GHG emissions and fuel consumption expected over the lifetime of each heavy-duty vehicle categories. In addition, because the agencies are carefully considering Alternative 4 along with Alternative 3, the preferred alternative, the results from both are presented here for the reader's reference. Section VII. C. (1) shows the impacts of the proposed rules and Alternative 4 on fuel consumption and GHG emissions using the MOVES model for tractor-trailers and vocational vehicles, and the DOT's CAFE model for HD pickups and vans (Method A), relative to two different reference cases—less dynamic and more dynamic. Section VII. C. (2) shows the impacts of the proposed standards and Alternative 4, relative to the less dynamic reference case only, using the MOVES model for all heavy-duty vehicle categories. NHTSA also analyzes these impacts resulting from the proposed rules and reasonable alternatives in Chapters 3 and 5 of its DEIS.

(1) Impacts of the Proposed Rules and Alternative 4 Using Analysis Method A

(a) Calendar Year Analysis

(i) Downstream (Tailpipe) Emissions Projections

As described in Section VII. A, for the analysis using Method A, the agencies used MOVES to estimate downstream GHG inventories from the proposed rules for vocational vehicles and tractor-trailers. For HD pickups and vans, DOT's CAFE model was used.

The following two tables summarize the agencies' estimates of HD pickup and van fuel consumption and GHG emissions under the current and proposed standards defining the No-Action and Preferred alternatives, respectively, using Method A. Table VII–9 shows results assuming manufacturers would voluntarily make improvements that pay back within six months (*i.e.,* Alternative 1b). Table VII–10 shows results assuming manufacturers would only make improvements as needed to achieve compliance with standards (*i.e.,* Alternative 1a). While underlying calculations are all performed for each calendar year during each vehicle's useful life, presentation of outcomes on a model year basis aligns more clearly with consideration of cost impacts in each model year, and with consideration of standards specified on a model year basis. In addition, Method A analyzes manufacturers' potential responses to HD pickup and van standards on a model year basis through 2030, and any longer-term costs presented in today's notice represent extrapolation of these results absent any underlying analysis of longer-term technology prospects and manufacturers' longer-term product offerings.

TABLE VII–9—ESTIMATED FUEL CONSUMPTION AND GHG EMISSIONS OVER USEFUL LIFE OF HD PICKUPS AND VANS PRODUCED IN EACH MODEL YEAR FOR METHOD A, RELATIVE TO ALTERNATIVE 1b[a]

Model year	Fuel consumption (b. gal.) over fleet's useful life			GHG emissions (MMT CO_2eq) over fleet's useful life		
	No action	Proposed	Reduction (%)	No action	Proposed	Reduction (%)
2014	9.41	9.41	0.0	115	115	0.0
2015	9.53	9.53	0.0	117	117	0.0
2016	9.72	9.72	0.0	119	119	0.0
2017	9.49	9.47	0.2	116	116	0.2
2018	9.26	9.19	0.7	113	113	0.7
2019	9.20	9.14	0.7	113	112	0.7
2020	9.19	9.12	0.7	112	112	0.7
2021	9.10	8.79	3.4	111	107	3.4
2022	9.13	8.82	3.4	112	108	3.4
2023	9.11	8.59	5.7	111	105	5.7
2024	9.32	8.72	6.4	114	107	6.4

TABLE VII–9—ESTIMATED FUEL CONSUMPTION AND GHG EMISSIONS OVER USEFUL LIFE OF HD PICKUPS AND VANS PRODUCED IN EACH MODEL YEAR FOR METHOD A, RELATIVE TO ALTERNATIVE 1b [a]—Continued

Model year	Fuel consumption (b. gal.) over fleet's useful life			GHG emissions (MMT CO_2eq) over fleet's useful life		
	No action	Proposed	Reduction (%)	No action	Proposed	Reduction (%)
2025	9.49	8.49	10.5	116	104	10.4
2026	9.67	8.56	11.5	118	105	11.3
2027	9.78	8.55	12.6	120	105	12.3
2028	9.90	8.66	12.6	121	106	12.3
2029	10.02	8.75	12.6	122	107	12.4
2030	10.03	8.76	12.6	123	107	12.4

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–10—ESTIMATED FUEL CONSUMPTION AND GHG EMISSIONS OVER USEFUL LIFE OF HD PICKUPS AND VANS PRODUCED IN EACH MODEL YEAR FOR METHOD A, RELATIVE TO ALTERNATIVE 1a [a]

Model year	Fuel consumption (b. gal.) over fleet's useful life			GHG Emissions (MMT CO_2eq) over fleet's useful life		
	No action	Proposed	Reduction (%)	No action	Proposed	Reduction (%)
2014	9.41	9.41	0.0	115	115	0.0
2015	9.53	9.53	0.0	117	117	0.0
2016	9.72	9.72	0.0	119	119	0.0
2017	9.49	9.46	0.3	116	116	0.3
2018	9.27	9.19	0.8	114	113	0.8
2019	9.20	9.14	0.7	113	112	0.7
2020	9.25	9.18	0.7	113	112	0.8
2021	9.23	8.82	4.4	113	108	4.4
2022	9.26	8.85	4.4	113	108	4.4
2023	9.23	8.60	6.9	113	105	6.9
2024	9.45	8.72	7.7	116	107	7.7
2025	9.62	8.48	11.8	118	104	11.7
2026	9.81	8.58	12.5	120	105	12.3
2027	9.93	8.57	13.7	121	105	13.5
2028	10.05	8.68	13.7	123	106	13.5
2029	10.17	8.77	13.7	124	108	13.5
2030	10.18	8.78	13.7	124	108	13.5

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

To more clearly communicate these trends visually, the following two charts present the above results graphically for Method A, relative to Alternative 1b. As shown, fuel consumption and GHG emissions follow parallel though not precisely identical paths. Though not presented, the charts for Alternative 1a would appear sufficiently similar that differences between Alternative 1a and Alternative 1b remain best communicated by comparing values in the above tables.

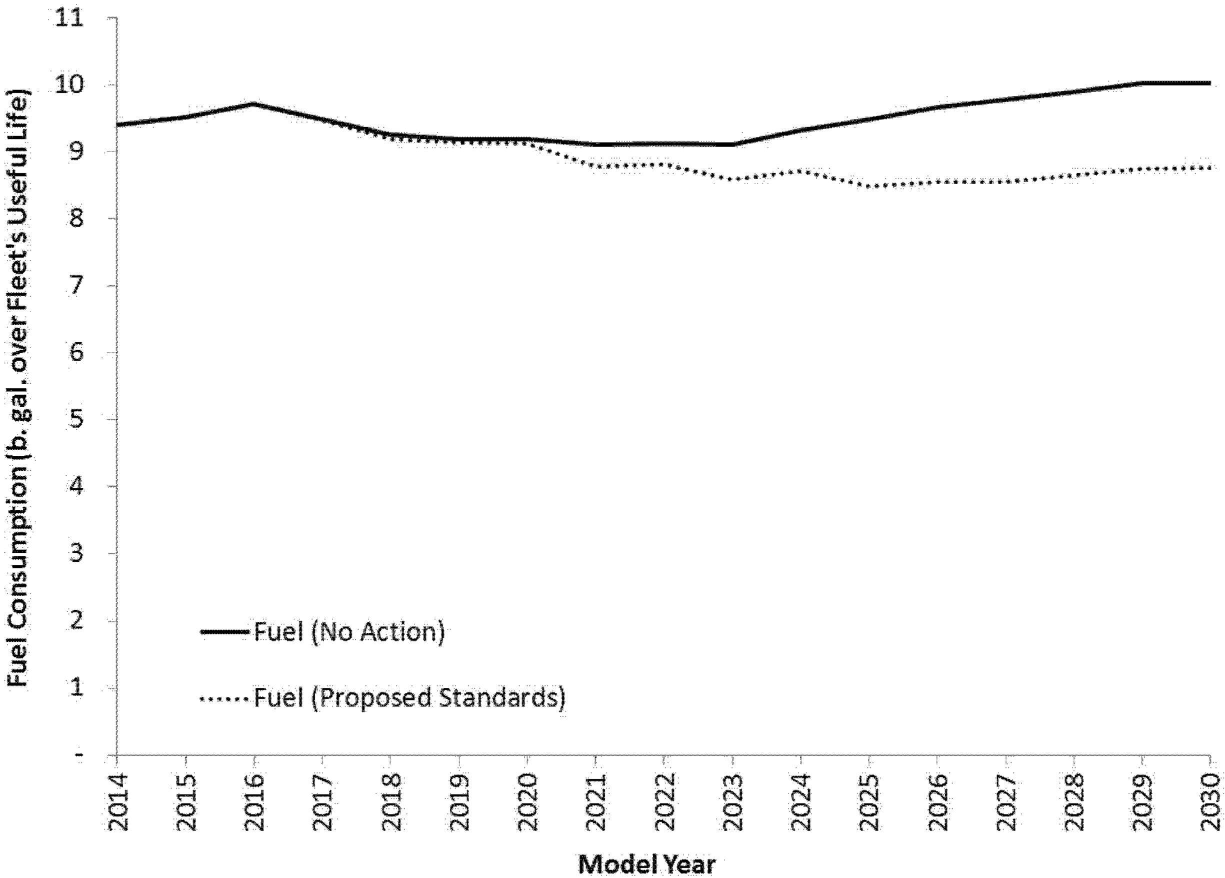

Figure VII-9 Fuel Consumption (b. gal.) over Useful Life of HD Pickups and Vans Produced in Each Model Year for Method A

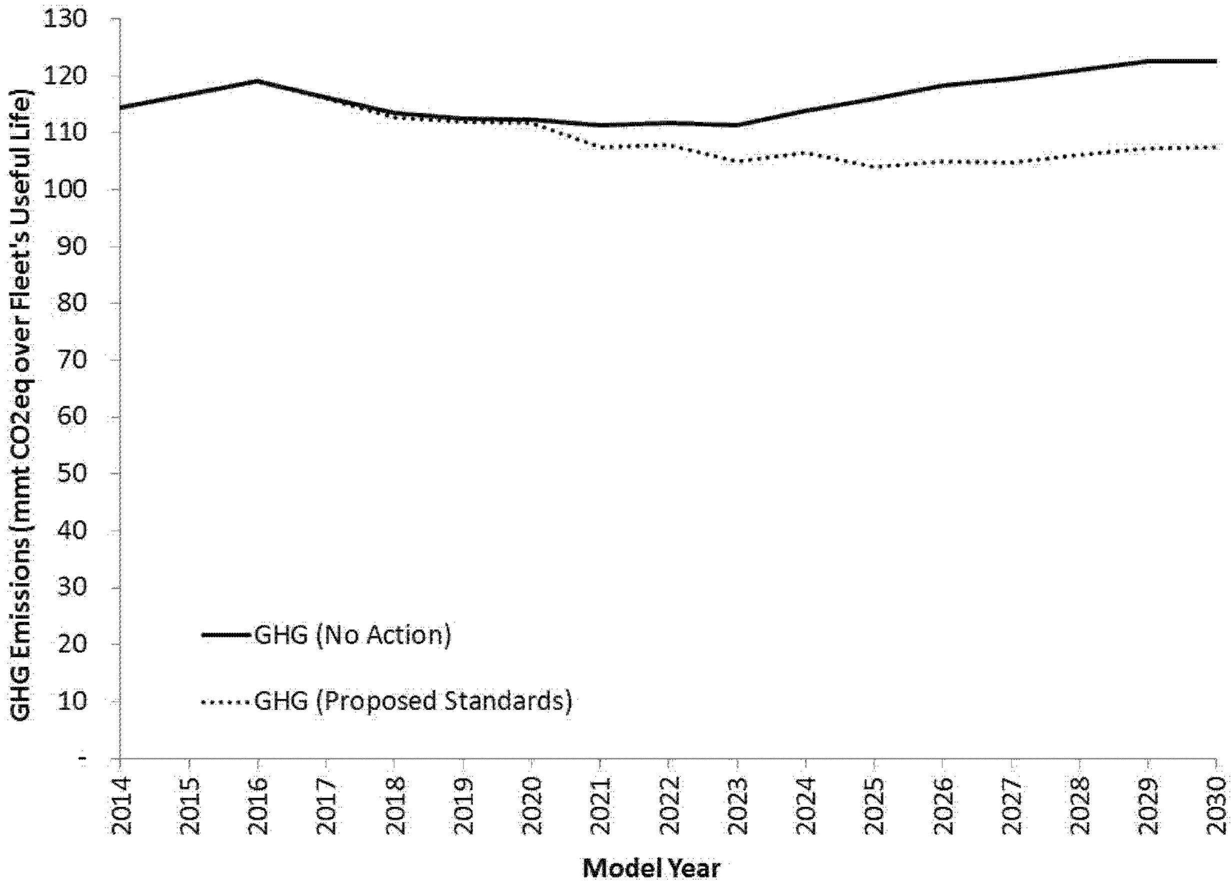

Figure VII-10 GHG Emissions (MMT CO_2eq) over Useful Life of HD Pickups and Vans Produced in Each Model Year for Method A

TABLE VII–11 ANNUAL DOWNSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1b USING ANALYSIS METHOD A[a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)[9]	Total downstream (MMT CO_2eq)
2025	−26.9	−0.4	0	−27.2
2035	−86.0	−1.0	0	−86.9
2050	−121.6	−1.4	0	−123.0

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–12—ANNUAL FUEL SAVINGS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1b USING ANALYSIS METHOD A[a]

CY	Diesel savings (billion gallons)	Gasoline savings (billion gallons)
2025	2.5	0.2
2035	7.6	0.9
2050	10.8	1.2

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–13—ANNUAL DOWNSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD A [a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)[9]	Total downstream (MMT CO_2eq)
2025	−27.7	−0.4	0	−28.1
2035	−93.6	−1.0	0	−94.6
2050	−133.5	−1.4	0	−134.9

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–14—ANNUAL FUEL SAVINGS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD A [a]

CY	Diesel savings (billion gallons)	Gasoline savings (billion gallons)
2025	2.5	0.2
2035	8.3	1.0
2050	11.9	1.3

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–15—ANNUAL DOWNSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1B USING ANALYSIS METHOD A [A]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)[9]	Total downstream (MMT CO_2eq)
2025	−33.2	−0.4	0	−33.5
2035	−89.9	−1.0	0	−90.9
2050	−122.6	−1.4	0	−124.0

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–16—ANNUAL FUEL SAVINGS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1b USING ANALYSIS METHOD A [a]

CY	Diesel savings (billion gallons)	Gasoline savings (billion gallons)
2025	3.0	0.3
2035	7.9	1.0
2050	10.8	1.3

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–17—ANNUAL DOWNSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD A [a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq) [9]	Total downstream (MMT CO_2eq)
2025	−34.3	−0.4	0	−34.6
2035	−97.7	−1.0	0	−98.7
2050	−134.6	−1.4	0	−136.0

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–18—ANNUAL FUEL SAVINGS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1A USING ANALYSIS METHOD A[a]

CY	Diesel savings (billion gallons)	Gasoline savings (billion gallons)
2025	3.1	0.3
2035	8.6	1.1
2050	12.0	1.3

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(ii) Upstream (Fuel Production and Distribution) Emissions Projections

TABLE VII–19—ANNUAL UPSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1b USING ANALYSIS METHOD A[a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)	Total upstream (MMT CO_2eq)
2025	−8.4	−0.9	−0.1	−9.3
2035	−26.6	−2.8	−0.2	−29.7
2050	−37.7	−4.0	−0.3	−42.0

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–20—ANNUAL UPSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1A USING ANALYSIS METHOD A[a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)	Total upstream (MMT CO_2eq)
2025	−8.6	−0.9	−0.1	−9.6
2035	−29.0	−3.1	−0.2	−32.3
2050	−41.4	−4.4	−0.3	−46.1

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–21—ANNUAL UPSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1b USING ANALYSIS METHOD A[a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)	Total upstream (MMT CO_2eq)
2025	−10.3	−1.1	−0.1	−11.5
2035	−27.8	−3.0	−0.2	−31.0
2050	−38.0	−4.0	−0.3	−42.3

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–22—ANNUAL UPSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD A[a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)	Total upstream (MMT CO_2eq)
2025	−10.6	−1.1	−0.1	−11.8
2035	−30.2	−3.2	−0.2	−33.7
2050	−41.7	−4.4	−0.3	−46.5

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(iii) HFC Emissions Projections

The projected HFC emission reductions due to the proposed AC leakage standards are 93,272 metric tons of CO_2eq in 2025, 253,118 metric tons of CO_2eq in 2035, and 299,590 metric tons CO_2eq in 2050.

(iv) Total (Downstream + Upstream + HFC) Emissions Projections

TABLE VII–23—ANNUAL TOTAL GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1b USING ANALYSIS METHOD A [a]

CY	2025 (MMT CO_2eq)	2035 (MMT CO_2eq)	2050 (MMT CO_2eq)
Downstream	−27.2	−86.9	−123.0
Upstream	−9.3	−29.7	−42.0
HFC	−0.09	−0.25	−0.3
Total	−36.4	−116.4	−164.7

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–24—ANNUAL TOTAL GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD A [a]

CY	2025 (MMT CO_2eq)	2035 (MMT CO_2eq)	2050 (MMT CO_2eq)
Downstream	−28.1	−94.6	−134.9
Upstream	−9.6	−32.3	−46.1
HFC	−0.09	−0.25	−0.3
Total	−37.6	−126.4	−180.7

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–25—ANNUAL TOTAL GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1b USING ANALYSIS METHOD A [a]

CY	2025 (MMT CO_2eq)	2035 (MMT CO_2eq)	2050 (MMT CO_2eq)
Downstream	−33.5	−90.9	−124.0
Upstream	−11.5	−31.0	−42.3
HFC	−0.09	−0.25	−0.3
Total	−44.9	−121.7	−166.0

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–26—ANNUAL TOTAL GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD A [a]

CY	2025 (MMT CO_2eq)	2035 (MMT CO_2eq)	2050 (MMT CO_2eq)
Downstream	−34.6	−98.7	−136.0
Upstream	−11.8	−33.7	−46.5
HFC	−0.09	−0.25	−0.3
Total	−46.3	−132.2	−182.2

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(b) Model Year Lifetime Analysis

TABLE VII–27—LIFETIME GHG REDUCTIONS AND FUEL SAVINGS USING ANALYSIS METHOD A—SUMMARY FOR MODEL YEARS 2018–2029 [a]

	Alternative 3 (proposed)		Alternative 4	
No–Action Alternative (Baseline)	1b (More Dynamic)	1a (Less Dynamic)	1b (More Dynamic)	1a (Less Dynamic)
Fuel Savings (Billion Gallons)	72.2	76.7	81.9	86.7
Total GHG Reductions (MMT CO_2eq)	974	1,034	1,102	1,166
Downstream (MMT CO_2eq)	726.1	771.3	821.9	870.3
Upstream (MMT CO_2eq)	247.7	262.9	279.9	296.1

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(2) Impacts of the Proposed Rules and Alternative 4 using Analysis Method B

(a) Calendar Year Analysis

(i) Downstream (Tailpipe) Emissions Projections

As described in Section VII. A., the Method B used MOVES to estimate downstream GHG inventories from the proposed rules and Alternative 4 relative to Alternative 1a for all heavy-duty vehicle categories (including the engines associated with tractor-trailer combinations and vocational vehicles). The agencies expect reductions in CO_2 emissions from all heavy-duty vehicle categories due to engine and vehicle improvements. We expect N_2O emissions to increase very slightly because of a rebound in vehicle miles traveled (VMT). However, since N_2O is produced as a byproduct of fuel combustion, the increase in N_2O emissions is expected to be more than offset by the improvements in fuel efficiency from the proposed rules.[388] We expect methane emissions to decrease primarily due to reduced refueling from improved fuel efficiency and the differences in hydrocarbon emission characteristics between on-road diesel engines and APUs. The amount of methane emitted as a fraction of total hydrocarbons is expected to be significantly less for APUs than for on-road diesel engines during extended idling. Overall, the downstream GHG emissions would be reduced significantly and are described in the following subsections.

Since fuel consumption is not directly modeled in MOVES, the total energy consumption was run as a surrogate in MOVES. Then, the total energy consumption was converted to fuel consumption based on the fuel heating values assumed in the Renewable Fuels Standard rulemaking [389] and used in the development of MOVES emission and energy rates.[390]

Table VII–28 and Table VII–29 show the impacts on downstream GHG emissions and fuel savings in 2025, 2035 and 2050, relative to Alternative 1a, for the preferred alternative and Alternative 4, respectively.

Table VII–30 and Table VII–31 show the estimated fuel savings from the preferred alternative and Alternative 4 in 2025, 2035, and 2050, relative to Alternative 1a. For both GHG emissions and fuel savings, the annual impacts are greater for Alternative 4 than the preferred alternative in earlier years, but the differences become indistinguishable by 2050. The results from the comparable analyses relative to Alternative 1b are presented in Section VII. C. (1).

TABLE VII–28—ANNUAL DOWNSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD B [a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)	Total downstream (MMT CO_2eq)
2025	−27.0	−0.4	0.002	−27.4
2035	−93.7	−1.0	0.004	−94.7
2050	−135.1	−1.4	0.005	−136.5

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–29—ANNUAL DOWNSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1A USING ANALYSIS METHOD B [a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)	Total downstream (MMT CO_2eq)
2025	−33.3	−0.4	0.002	−33.7
2035	−97.3	−1.0	0.004	−98.3
2050	−135.5	−1.4	0.005	−136.9

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[388] MOVES is not capable of modeling the changes in exhaust N_2O emissions from the improvements in fuel efficiency. Due to this limitation, a conservative approach was taken to only model the VMT rebound in estimating the emissions impact on N_2O from the proposed rules, resulting in a slight increase in downstream N_2O inventory.

[389] Renewable Fuels Standards assumptions of 115,000 BTU/gallon gasoline (E0) and 76,330 BTU/gallon ethanol (E100) were weighted 90% and 10%, respectively, for E10 and 85% and 15%, respectively, for E15 and converted to kJ at 1.055 kJ/BTU. The conversion factors are 117,245 kJ/gallon for gasoline blended with ten percent ethanol (E10) and 115,205 kJ/gallon for gasoline blended with fifteen percent ethanol (E15).

[390] The conversion factor for diesel is 138,451 kJ/gallon. See MOVES2004 Energy and Emission Inputs. EPA420–P–05–003, March 2005. *http://www.epa.gov/otaq/models/ngm/420p05003.pdf* (last accessed Feb 23, 2015).

TABLE VII–30—ANNUAL FUEL SAVINGS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD B[a]

CY	Diesel savings (billion gallons)	Gasoline savings (billion gallons)
2025	2.5	0.2
2035	8.5	0.8
2050	12.3	1.1

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–31—ANNUAL FUEL SAVINGS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD B[a]

CY	Diesel savings (billion gallons)	Gasoline savings (billion gallons)
2025	3.1	0.3
2035	8.8	0.9
2050	12.3	1.1

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(ii) Upstream (Fuel Production and Distribution) Emissions Projections

The upstream GHG emission reductions associated with the production and distribution of gasoline and diesel from crude oil were based on emission factors from DOE's ''Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation'' (GREET) model. In some cases, the GREET values were modified or updated by the agencies to be consistent with EPA's National Emissions Inventory (NEI), and emission factors from MOVES. More information regarding these modifications can be found in Chapter 5 of the draft RIA. These estimates show the impacts for domestic emission reductions only. Additionally, since this rulemaking is not expected to impact biofuel volumes mandated by the Annual Renewable Fuel Standards (RFS) regulations[391], the impacts on upstream emissions from changes in biofuel feedstock (*i.e.,* agricultural sources such as fertilizer, fugitive dust, and livestock) are not shown. GHG emission reductions from upstream sources can be found in Table VII–32 and Table VII–33 for preferred alternative and Alternative 4, respectively.

TABLE VII–32—ANNUAL UPSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD B[a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)	Total uptream (MMT CO_2eq)
2025	−8.4	−0.9	−0.04	−9.3
2035	−29.1	−3.0	−0.14	−32.2
2050	−41.9	−4.4	−0.20	−46.5

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–33—ANNUAL UPSTREAM GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD B[a]

CY	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)	Total uptream (MMT CO_2eq)
2025	−10.4	−1.0	−0.1	−11.5
2035	−30.1	−3.2	−0.1	−33.4
2050	−42.0	−4.4	−0.2	−46.6

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(iii) HFC Emissions Projections

Based on projected HFC emission reductions due to the proposed AC leakage standards, EPA estimates the HFC reductions to be 93,272 metric tons of CO_2eq in 2025, 253,118 metric tons of CO_2eq in 2035, and 299,590 metric tons CO_2eq in 2050, as detailed in Chapters 5.3.4 of the draft RIA. EPA welcomes comments on the methodology used to quantify the HFC emissions benefits, as detailed in Chapter 5 of the draft RIA.

(iv) Total (Downstream + Upstream + HFC) Emissions Projections

Table VII–34 combines the impacts of the preferred alternative from downstream (Table VII–28), upstream (Table VII–32), and HFC to summarize the total GHG reductions in calendar years 2025, 2035 and 2050, relative to Alternative 1a. The combined impact of Alternative 4 on total GHG emissions are shown in Table VII–35.

Because of the differences in lead time, as expected, Alternative 4 shows greater annual GHG reductions in earlier years (*i.e.,* calendar year 2025), but by

[391] U.S. EPA. 2014 Standards for the Renewable Fuel Standard Program. 40 CFR part 80. EPA–HQ–OAR–2013–0479; FRL–9900–90–OAR, RIN 2060–AR76.

2050, the preferred alternative and Alternative 4 show the same magnitude of reductions in annual GHG emissions.

TABLE VII–34—ANNUAL TOTAL GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD B [a]

CY	2025 (MMT CO_2eq)	2035 (MMT CO_2eq)	2050 (MMT CO_2eq)
Downstream	−27.4	−94.7	−136.5
Upstream	−9.3	−32.2	−46.5
HFC	−0.1	−0.25	−0.3
Total	−36.8	−127.2	−183.3

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VII–35—ANNUAL TOTAL GHG EMISSIONS IMPACTS IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD B [a]

CY	2025 (MMT CO_2eq)	2035 (MMT CO_2eq)	2050 (MMT CO_2eq)
Downstream	−33.7	−98.3	−136.9
Upstream	−11.5	−33.4	−46.6
HFC	−0.1	−0.25	−0.3
Total	−45.3	−132.0	−183.8

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(b) Model Year Lifetime Analysis

In addition to the annual GHG emissions and fuel consumption reductions expected from the proposed rules and Alternative 4, the combined (downstream and upstream) GHG and fuel consumption impacts for the lifetime of the impacted vehicles were estimated. Table VII–36 shows the fleet-wide GHG reductions and fuel savings from the preferred alternative and Alternative 4, relative to Alternative 1a, through the lifetime [392] of heavy-duty vehicles. Compared to the preferred alternative, Alternative 4 shows greater lifetime GHG reductions and fuels savings by 12 percent and 13 percent, respectively. For the lifetime GHG reductions and fuel savings by vehicle categories, see Chapter 5 of the draft RIA.

TABLE VII–36—LIFETIME GHG REDUCTIONS AND FUEL SAVINGS USING ANALYSIS METHOD B—SUMMARY FOR MODEL YEARS 2018–2029 [a]

Model years	Alternative 3 (proposed)	Alternative 4
No-action alternative (baseline)	1a (less dynamic)	1a (less dynamic)
Fuel Savings (Billion Gallons)	75.8	85.4
Total GHG Reductions (MMT CO_2eq)	1,036.4	1,163.1
Downstream (MMT CO_2eq)	772.6	867.3
Upstream (MMT CO_2eq)	263.8	295.8

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

D. Climate Impacts and Indicators

(1) Climate Change Impacts From GHG Emissions

The impact of GHG emissions on the climate has been reviewed in the 2009 Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, the 2012–2016 light-duty vehicle rulemaking, the 2014–2018 heavy-duty vehicle GHG and Fuel Efficiency rulemaking, and the 2017–2025 light-duty vehicle rulemaking, and the proposed standards for new electricity utility generating units. See 74 FR 66496; 75 FR 25491; 76 FR 57294; 77 FR 62894; 79 FR 1456–1459 (January 8, 2014). This section briefly discusses again some of the climate impact of EPA's proposed actions in context of transportation emissions. NHTSA has analyzed the climate impacts of its specific proposed actions (*i.e.,* excluding EPA's HFC regulatory provisions) as well as reasonable alternative in its DEIS that accompanies

[392] A lifetime of 30 years is assumed in MOVES.

this proposed rule. DOT has considered the potential climate impacts documented in the DEIS as part of the rulemaking process.

Once emitted, GHGs that are the subject of this proposed regulation can remain in the atmosphere for decades to millennia, meaning that (1) their concentrations become well-mixed throughout the global atmosphere regardless of emission origin, and (2) their effects on climate are long lasting. GHG emissions come mainly from the combustion of fossil fuels (coal, oil, and gas), with additional contributions from the clearing of forests, agricultural activities, cement production, and some industrial activities. Transportation activities, in aggregate, were the second largest contributor to total U.S. GHG emissions in 2010 (27 percent of total emissions).[393]

The EPA Administrator relied on thorough and peer-reviewed assessments of climate change science prepared by the Intergovernmental Panel on Climate Change (''IPCC''), the United States Global Change Research Program (''USGCRP''), and the National Research Council of the National Academies (''NRC'') [394] as the primary scientific and technical basis for the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act (74 FR 66496, December 15, 2009). These assessments comprehensively address the scientific issues the EPA Administrator had to examine, providing her data and information on a wide range of issues pertinent to the Endangerment Finding. These assessments have been rigorously reviewed by the expert community, and also by United States government agencies and scientists, including by EPA itself.

Based on these assessments, the EPA Administrator determined that the emissions from new motor vehicles and engines contributes to elevated concentrations of greenhouse gases, that these greenhouse gases cause warming; that the recent warming has been attributed to the increase in greenhouse gases; and that warming of the climate endangers the public health and welfare of current and future generations. See *Coalition for Responsible Regulation* v. *EPA,* 684 F. 3d 102, 121 (D.C. Cir. 2012) (upholding all of EPA's findings and stating ''EPA had before it substantial record evidence that anthropogenic emissions of greenhouse gases 'very likely' caused warming of the climate over the last several decades. EPA further had evidence of current and future effects of this warming on public health and welfare. Relying again upon substantial scientific evidence, EPA determined that anthropogenically induced climate change threatens both public health and public welfare. It found that extreme weather events, changes in air quality, increases in food- and water-borne pathogens, and increases in temperatures are likely to have adverse health effects. The record also supports EPA's conclusion that climate change endangers human welfare by creating risk to food production and agriculture, forestry, energy, infrastructure, ecosystems, and wildlife. Substantial evidence further supported EPA's conclusion that the warming resulting from the greenhouse gas emissions could be expected to create risks to water resources and in general to coastal areas as a result of expected increase in sea level.'')

A number of major peer-reviewed scientific assessments have been released since the administrative record concerning the Endangerment Finding closed following EPA's 2010 Reconsideration Denial.[395] These assessments include the ''Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation'' [396], the 2013–14 Fifth Assessment Report (AR5),[397] the 2014 National Climate Assessment report,[398] the ''Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean,'' [399] ''Report on Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia,'' [400] ''National Security Implications for U.S. Naval Forces'' (National Security Implications),[401] ''Understanding Earth's Deep Past: Lessons for Our Climate Future,'' [402] ''Sea Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future,'' [403] ''Climate and Social Stress: Implications for Security Analysis,'' [404] and ''Abrupt Impacts of Climate Change'' (Abrupt Impacts) assessments.[405]

EPA has reviewed these assessments and finds that in general, the improved understanding of the climate system they present are consistent with the assessments underlying the 2009 Endangerment Finding.

The most recent assessments released were the IPCC AR5 assessments between September 2013 and April 2014, the NRC Abrupt Impacts assessment in December of 2013, and the U.S. National Climate Assessment in May of 2014. The NRC Abrupt Impacts report examines the potential for tipping points, thresholds beyond which major and rapid changes occur in the Earth's climate system or other systems impacted by the climate. The Abrupt

[393] U.S. EPA (2012) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010. EPA 430–R–12–001. Available at *http://epa.gov/climatechange/emissions/downloads12/US-GHG-Inventory-2012-Main-Text.pdf.*

[394] For a complete list of core references from IPCC, USGCRP/CCSP, NRC and others relied upon for development of the TSD for EPA's Endangerment and Cause or Contribute Findings see section 1(b), specifically, Table 1.1 of the TSD. (Docket EPA–HQ–OAR–2010–0799)

[395] ''EPA's Denial of the Petitions to Reconsider the Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act'', 75 FR 49,556 (Aug. 13, 2010) (''Reconsideration Denial'').

[396] Intergovernmental Panel on Climate Change (IPCC). 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaption. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA.

[397] Intergovernmental Panel on Climate Change (IPCC). 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[398] Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program. Available at *http://nca2014.globalchange.gov.*

[399] National Research Council (NRC). 2010. Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean. National Academies Press. Washington, DC.

[400] National Research Council (NRC). 2011. Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia. National Academies Press, Washington, DC.

[401] National Research Council (NRC) 2011. National Security Implications of Climate Change for U.S. Naval Forces. National Academies Press. Washington, DC.

[402] National Research Council (NRC). 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. National Academies Press. Washington, DC.

[403] National Research Council (NRC). 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. National Academies Press. Washington, DC.

[404] National Research Council (NRC). 2013. Climate and Social Stress: Implications for Security Analysis. National Academies Press. Washington, DC.

[405] National Research Council (NRC). 2013. Abrupt Impacts of Climate Change: Anticipating Surprises. National Academies Press. Washington, DC.

Impacts report did find less cause for concern than some previous assessments regarding some abrupt events within the next century such as disruption of the Atlantic Meridional Overturning Circulation (AMOC) and sudden releases of high-latitude methane from hydrates and permafrost, but found that the potential for abrupt changes in ecosystems, weather and climate extremes, and groundwater supplies critical for agriculture now seem more likely, severe, and imminent. The assessment found that some abrupt changes were already underway (Arctic sea ice retreat and increases in extinction risk due to the speed of climate change), but cautioned that even abrupt changes such as the AMOC disruption that are not expected in this century can have severe impacts when they happen.

The IPCC AR5 assessments are also generally consistent with the underlying science supporting the 2009 Endangerment Finding. For example, confidence in attributing recent warming to human causes has increased: The IPCC stated that it is extremely likely (>95 percent confidence) that human influences have been the dominant cause of recent warming. Moreover, the IPCC found that the last 30 years were likely (>66 percent confidence) the warmest 30 year period in the Northern Hemisphere of the past 1400 years, that the rate of ice loss of worldwide glaciers and the Greenland and Antarctic ice sheets has likely increased, that there is medium confidence that the recent summer sea ice retreat in the Arctic is larger than it has been in 1450 years, and that concentrations of carbon dioxide and several other of the major greenhouse gases are higher than they have been in at least 800,000 years. Climate-change induced impacts have been observed in changing precipitation patterns, melting snow and ice, species migration, negative impacts on crops, increased heat and decreased cold mortality, and altered ranges for water-borne illnesses and disease vectors. Additional risks from future changes include death, injury, and disrupted livelihoods in coastal zones and regions vulnerable to inland flooding, food insecurity linked to warming, drought, and flooding, especially for poor populations, reduced access to drinking and irrigation water for those with minimal capital in semi-arid regions, and decreased biodiversity in marine ecosystems, especially in the Arctic and tropics, with implications for coastal livelihoods. The IPCC determined that ''[c]ontinued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gases emissions.''

Finally, the recently released National Climate Assessment stated, ''Climate change is already affecting the American people in far reaching ways. Certain types of extreme weather events with links to climate change have become more frequent and/or intense, including prolonged periods of heat, heavy downpours, and, in some regions, floods and droughts. In addition, warming is causing sea level to rise and glaciers and Arctic sea ice to melt, and oceans are becoming more acidic as they absorb carbon dioxide. These and other aspects of climate change are disrupting people's lives and damaging some sectors of our economy.''

Assessments from these bodies represent the current state of knowledge, comprehensively cover and synthesize thousands of individual studies to obtain the majority conclusions from the body of scientific literature and undergo a rigorous and exacting standard of review by the peer expert community and U.S. government.

Based on modeling analysis performed by the agencies, reductions in CO_2 and other GHG emissions associated with these proposed rules will affect future climate change. Since GHGs are well-mixed in the atmosphere and have long atmospheric lifetimes, changes in GHG emissions will affect atmospheric concentrations of greenhouse gases and future climate for decades to millennia, depending on the gas. This section provides estimates of the projected change in atmospheric CO_2 concentrations based on the emission reductions estimated for these proposed rules, compared to the reference case. In addition, this section analyzes the response to the changes in GHG concentrations of the following climate-related variables: Global mean temperature, sea level rise, and ocean pH.

(2) Projected Change in Atmospheric CO_2 Concentrations, Global Mean Surface Temperature and Sea Level Rise

To assess the impact of the emissions reductions from the proposed rules, EPA estimated changes in projected atmospheric CO_2 concentrations, global mean surface temperature and sea-level rise to 2100 using the GCAM (Global Change Assessment Model, formerly MiniCAM), integrated assessment model[406] coupled with the MAGICC (Model for the Assessment of Greenhouse-gas Induced Climate Change) simple climate model.[407] GCAM was used to create the globally and temporally consistent set of climate relevant emissions required for running MAGICC. MAGICC was then used to estimate the projected change in relevant climate variables over time. Given the magnitude of the estimated emissions reductions associated with these rules, a simple climate model such as MAGICC is appropriate for estimating the atmospheric and climate response.

The analysis projects that the proposed rules would reduce atmospheric concentrations of CO_2, global climate warming, ocean acidification, and sea level rise relative to the reference case. Although the projected reductions and improvements are small in comparison to the total projected climate change, they are quantifiable, directionally consistent, and will contribute to reducing the risks associated with climate change. Climate change is a global phenomenon and EPA recognizes that this one national action alone will not prevent it; EPA notes this would be true for any given GHG mitigation action when taken alone or when considered in isolation. EPA also notes that a substantial portion of CO_2 emitted into the atmosphere is not removed by natural processes for millennia, and therefore each unit of CO_2 not emitted into the atmosphere due to this rules avoids essentially permanent climate change on centennial time scales.

EPA determines that the projected reductions in atmospheric CO_2, global mean temperature, sea level rise, and ocean pH are meaningful in the context of this action. The results of the analysis, summarized in Table VII–37, demonstrate that relative to the

[406] GCAM is a long-term, global integrated assessment model of energy, economy, agriculture and land use that considers the sources of emissions of a suite of greenhouse gases (GHG's), emitted in 14 globally disaggregated regions, the fate of emissions to the atmosphere, and the consequences of changing concentrations of greenhouse related gases for climate change. GCAM begins with a representation of demographic and economic developments in each region and combines these with assumptions about technology development to describe an internally consistent representation of energy, agriculture, land-use, and economic developments that in turn shape global emissions.

[407] MAGICC consists of a suite of coupled gas-cycle, climate and ice-melt models integrated into a single framework. The framework allows the user to determine changes in greenhouse-gas concentrations, global-mean surface air temperature and sea-level resulting from anthropogenic emissions of carbon dioxide (CO_2), methane (CH4), nitrous oxide (N2O), reactive gases (CO, NO_X, VOCs), the halocarbons (*e.g.* HCFCs, HFCs, PFCs) and sulfur dioxide (SO_2). MAGICC emulates the global-mean temperature responses of more sophisticated coupled Atmosphere/Ocean General Circulation Models (AOGCMs) with high accuracy.

reference case, by 2100 projected atmospheric CO_2 concentrations are estimated to be reduced by 1.1 to 1.2 part per million by volume (ppmv), global mean temperature is estimated to be reduced by 0.0026 to 0.0065 °C, and sea-level rise is projected to be reduced by approximately 0.023 to 0.057 cm, based on a range of climate sensitivities (described below). Details about this modeling analysis can be found in the draft RIA Chapter 6.3.

TABLE VII–37—IMPACT OF GHG EMISSIONS REDUCTIONS ON PROJECTED CHANGES IN GLOBAL CLIMATE ASSOCIATED WITH PROPOSED PHASE 2 STANDARDS FOR MY 2018–2024

[Based on a range of climate sensitivities from 1.5–6 °C]

Variable	Units	Year	Projected change
Atmospheric CO_2 CONCENTRATION	ppmv	2100	−1.1 to −1.2
Global Mean Surface Temperature	°C	2100	−0.0026 to −0.0065
Sea Level Rise	cm	2100	−0.023 to −0.057
Ocean pH	pH units	2100	+0.0006 [a]

Note:
[a] The value for projected change in ocean pH is based on a climate sensitivity of 3.0.

The projected reductions are small relative to the change in temperature (1.8–4.8 °C), CO_2 concentration (404 to 470 ppm), sea level rise (23–56 cm), and ocean acidity (−0.30 pH units) from 1990 to 2100 from the MAGICC simulations for the GCAM reference case. However, this is to be expected given the magnitude of emissions reductions expected from the program in the context of global emissions. Moreover, these effects are occurring everywhere around the globe, so benefits that appear to be marginal for any one location, such as a reduction in seal level rise of half a millimeter, can be sizable when the effects are summed along thousands of miles of coastline. This uncertainty range does not include the effects of uncertainty in future emissions. It should also be noted that the calculations in MAGICC do not include the possible effects of accelerated ice flow in Greenland and/or Antarctica: Estimates of sea level rise from the recent NRC, IPCC, and NCA assessments range from 26 cm to 2 meters depending on the emissions scenario, the processes included, and the likelihood range assessed; inclusion of these effects would lead to correspondingly larger benefits of mitigation. Further discussion of EPA's modeling analysis is found in the RIA, Chapter 6.3.

Based on the projected atmospheric CO_2 concentration reductions resulting from these proposed rules, EPA calculates an increase in ocean pH of 0.0006 pH units in 2100 relative to the baseline case (this is a reduction in the expected acidification of the ocean of a decrease of 0.3 pH units from 1990 to 2100 in the baseline case). Thus, this analysis indicates the projected decrease in atmospheric CO_2 concentrations from the proposed Phase 2 standards would result in an increase in ocean pH (*i.e.,* a reduction in the expected acidification of the ocean in the reference case). A more detailed discussion of the modeling analysis associated with ocean pH is provided in the draft RIA, Chapter 6.3.

The 2011 NRC assessment on ''Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia'' determined how a number of climate impacts—such as heaviest daily rainfalls, crop yields, and Arctic sea ice extent—would change with a temperature change of 1 degree Celsius (C) of warming. These relationships of impacts with temperature change could be combined with the calculated reductions in warming in Table VII–37 to estimate changes in these impacts associated with this proposed rulemaking.

As a substantial portion of CO_2 emitted into the atmosphere is not removed by natural processes for millennia, each unit of CO_2 not emitted into the atmosphere avoids some degree of effectively permanent climate change. Therefore, reductions in emissions in the near-term are important in determining climate impacts experienced not just over the next decades but over thousands of years.[408] Though the magnitude of the avoided climate change projected here in isolation is small in comparison to the total projected changes, these reductions represent a reduction in the adverse risks associated with climate change (though these risks were not formally estimated for this action) across a range of equilibrium climate sensitivities.

EPA's analysis of this proposed rule's impact on global climate conditions is intended to quantify these potential reductions using the best available science. EPA's modeling results show consistent reductions relative to the baseline case in changes of CO_2 concentration, temperature, sea-level rise, and ocean pH over the next century.

[408] National Research Council (NRC) (2011). Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia. National Academy Press. Washington, DC. (Docket EPA–HQ–OAR–2010–0799)

VIII. How will this proposed action impact non-GHG emissions and their associated effects?

The proposed heavy-duty vehicle standards are expected to influence the emissions of criteria air pollutants and several air toxics. This section describes the projected impacts of the proposed rules and Alternative 4 on non-GHG emissions and air quality, and the health and environmental effects associated with these pollutants. NHTSA further analyzes these projected health and environmental effects resulting from its proposed rules and reasonable alternatives in Chapter 4 of its DEIS.

A. Emissions Inventory Impacts

As described in Section VII, the agencies conducted coordinated and complementary analyses for these rules by employing both DOT's CAFE model and EPA's MOVES model, relative to different reference cases (*i.e.,* different baselines). The agencies used EPA's MOVES model to estimate the non-GHG impacts for tractor-trailers (including the engine that powers the vehicle), and vocational vehicles (including the engine that powers the vehicle). For heavy-duty pickups and vans, the agencies performed complementary analyses using the CAFE model (''Method A'') and the MOVES model (''Method B'') to estimate non-GHG emissions from these vehicles. For both methods, the agencies analyzed the impact of the proposed rules, relative to two different reference cases—less dynamic and more dynamic. The less dynamic baseline projects very little improvement in new vehicles in the absence of new Phase 2 standards. In contrast, the more dynamic baseline projects more improvements in vehicle fuel efficiency. The agencies considered both reference cases. The results for all of the regulatory alternatives relative to both reference cases, derived via the same methodologies discussed in Section VII of the Preamble, are presented in Section X of the Preamble.

For brevity, a subset of these analyses are presented in this section and the reader is referred to both the RIA Chapter 11 and NHTSA's DEIS Chapters 3 and 5 for complete sets of these analyses. In this section, Method A is presented for both the proposed standards (*i.e.,* Alternative 3—the agencies' preferred alternative) and for the standards the agencies considered in Alternative 4, relative to both the more dynamic baseline (Alternative 1b) and the less dynamic baseline (Alternative 1a). Method B is presented also for the proposed standards and Alternative 4, but relative only to the less dynamic baseline. The agencies' intention for presenting both of these complementary and coordinated analyses is to offer interested readers the opportunity to compare the regulatory alternatives considered for Phase 2 in both the context of our HD Phase 1 analytical approaches and our light-duty vehicle analytical approaches. The agencies view these analyses as corroborative and reinforcing: Both support agencies' conclusion that the proposed standards are appropriate and at the maximum feasible levels.

The following subsections summarize two slightly different analyses of the annual non-GHG emissions reductions expected from the proposed standards and Alternative 4. Section VIII. A. (1) presents the impacts of the proposed rules and Alternative 4 on non-GHG emissions using the analytical Method A, relative to two different reference cases—less dynamic and more dynamic. Section VIII. A. (2) presents the impacts of the proposed standards and Alternative 4, relative to the less dynamic reference case only, using the MOVES model for all heavy-duty vehicle categories.

(1) Impacts of the Proposed Rules and Alternative 4 Using Analysis Method A

(a) Calendar Year Analysis

(i) Upstream Impacts of the Proposed Program and Alternative 4

Increasing efficiency in heavy-duty vehicles would result in reduced fuel demand, and therefore, reductions in the emissions associated with all processes involved in getting petroleum to the pump. Both Method A and Method B project these impacts for fuel consumed by vocational vehicles and combination tractor-trailers, using the same methods. See Section VIII.A.(2)(a)(i) for the description of this methodology. To project these impacts for fuel consumed by HD pickups and vans, Method A used similar calculations and inputs applicable to the CAFE model, as discussed above in Section VI. More information on the development of the emission factors used in this analysis can be found in Chapter 5 of the draft RIA.

The following four tables summarize the projected upstream emission impacts of the preferred alternative and Alternative 4 on both criteria pollutants and air toxics from the heavy-duty sector, relative to Alternative 1b (more dynamic baseline conditions under the No-Action Alternative) and Alternative 1a (less dynamic baseline conditions under the No-Action Alternative).

TABLE VIII–1—ANNUAL UPSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1b USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−1	−5	−3	−14	−5	−17
Acetaldehyde	−3	−3	−10	−11	−15	−13
Acrolein	0	−4	−1	−12	−2	−15
Benzene	−21	−4	−74	−13	−104	−15
CO	−3,798	−5	−12,087	−14	−17,120	−17
Formaldehyde	−19	−5	−59	−14	−84	−17
NO_X	−9,472	−5	−30,333	−14	−42,839	−17
$PM_{2.5}$	−1,019	−5	−3,257	−14	−4,609	−17
SO_X	−5,983	−5	−19,190	−14	−27,074	−17
VOC	−3,066	−4	−11,029	−13	−15,386	−15

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VIII–2—ANNUAL UPSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1b USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−1	−6	−3	−15	−5	−17
Acetaldehyde	−4	−5	−11	−12	−15	−14
Acrolein	−1	−5	−1	−13	−2	−15
Benzene	−28	−5	−78	−13	−105	−16
CO	−4,679	−6	−12,640	−15	−17,263	−17
Formaldehyde	−23	−6	−62	−15	−85	−17
NO_X	−11,708	−6	−31,769	−15	−43,263	−17
$PM_{2.5}$	−1,259	−6	−3,408	−15	−4,649	−17
SO_X	−7,402	−6	−20,107	−15	−27,356	−17

TABLE VIII–2—ANNUAL UPSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1b USING ANALYSIS METHOD A [a]—Continued

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
VOC	−4,081	−5	−11,717	−13	−15,645	−15

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VIII–3—ANNUAL UPSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−1	−5	−4	−15	−5	−18
Acetaldehyde	−3	−3	−11	−12	−16	−14
Acrolein	0	−4	−1	−13	−2	−15
Benzene	−22	−4	−80	−14	−113	−16
CO	−3,911	−5	−13,153	−15	−18,794	−18
Formaldehyde	−19	−5	−65	−15	−92	−18
NO_X	−9,787	−5	−33,021	−15	−47,028	−18
$PM_{2.5}$	−1,051	−5	−3,545	−15	−5,058	−18
SO_X	−6,189	−5	−20,896	−15	−29,726	−18
VOC	−3,193	−4	−11,848	−13	−16,625	−16

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VIII–4—ANNUAL UPSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−1	−6	−4	−16	−5	−18
Acetaldehyde	−4	−5	−12	−12	−16	−14
Acrolein	−1	−5	−1	−13	−2	−16
Benzene	−29	−5	−84	−14	−114	−17
CO	−4,816	−6	−13,720	−16	−18,945	−18
Formaldehyde	−24	−6	−67	−16	−93	−18
NO_X	−12,098	−6	−34,501	−16	−47,477	−18
$PM_{2.5}$	−1,298	−6	−3,700	−16	−5,101	−18
SO_X	−7,658	−6	−21,843	−16	−30,024	−18
VOC	−4,251	−5	−12,541	−14	−16,870	−16

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(ii) Downstream Impacts of the Proposed Program and Alternative 4

For vocational vehicles and tractor-trailers, the agencies used the MOVES model to determine non-GHG emissions inventories. The improvements in engine efficiency and road load, the increased use of APUs, and VMT rebound were included in the MOVES analysis. For the analysis presented in this section, the DOT CAFE model was used for HD pickups and vans. Further information about DOT's CAFE model is available in Section VI.C and Chapter 10 of the draft RIA. The following four tables summarize the projected downstream emission impacts of the preferred alternative and Alternative 4 on both criteria pollutants and air toxics from the heavy-duty sector, relative to Alternative 1b and Alternative 1a.

TABLE VIII–5—ANNUAL DOWNSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1b USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−8	−3	−21	−12	−30	−16
Acetaldehyde	−669	−10	−1,882	−31	−2,667	−36
Acrolein	−97	−10	−272	−31	−385	−37
Benzene	−123	−6	−347	−19	−490	−24
CO	−26,485	−3	−75,199	−8	−106,756	−9
Formaldehyde	−2,100	−12	−5,910	−32	−8,376	−37
NO_X	−92,444	−7	−260,949	−28	−370,663	−34
$PM_{2.5}$ [b]	643	2	1,722	8	2,410	10
SO_X	−229	−4	−715	−13	−1,026	−15
VOC	−13,161	−6	−38,051	−21	−54,139	−26

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Positive number means emissions would increase from reference to control case. $PM_{2.5}$ from tire wear and brake wear are included.

TABLE VIII–6—ANNUAL DOWNSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1b USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−8	−2	−21	−12	−30	−16
Acetaldehyde	−669	−10	−1,882	−31	−2,667	−36
Acrolein	−97	−10	−271	−31	−385	−37
Benzene	−124	−6	−347	−19	−490	−24
CO	−26,705	−3	−75,407	−8	−106,874	−9
Formaldehyde	−2,100	−12	−5,908	−32	−8,375	−37
NO_X	−93,984	−8	−262,150	−28	−370,704	−34
$PM_{2.5}$ [b]	619	2	1,705	8	2,412	10
SO_X	−280	−5	−742	−13	−1,029	−15
VOC	−13,925	−7	−38,472	−22	−54,150	−26

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Positive number means emissions would increase from reference to control case. $PM_{2.5}$ from tire wear and brake wear are included.

TABLE VIII–7—ANNUAL DOWNSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−8	−3	−21	−12	−30	−16
Acetaldehyde	−669	−10	−1,880	−31	−2,664	−36
Acrolein	−97	−10	−271	−31	−384	−37
Benzene	−123	−6	−346	−19	−490	−24
CO	−26,576	−3	−75,571	−8	−107,287	−9
Formaldehyde	−2,100	−12	−5,904	−32	−8,369	−37
NO_X	−93,197	−8	−266,890	−29	−380,303	−35
$PM_{2.5}$ [b]	632	2	1,635	8	2,267	9
SO_X	−232	−4	−776	−14	−1,125	−16
VOC	−13,210	−6	−38,964	−22	−55,628	−26

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Positive number means emissions would increase from reference to control case. $PM_{2.5}$ from tire wear and brake wear are included.

TABLE VIII–8—ANNUAL DOWNSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−8	−2	−21	−12	−29	−16
Acetaldehyde	−668	−10	−1,880	−31	−2,664	−36
Acrolein	−97	−10	−271	−31	−384	−37
Benzene	−124	−6	−346	−19	−489	−24
CO	−26,821	−3	−75,795	−8	−107,414	−9
Formaldehyde	−2,099	−12	−5,902	−32	−8,367	−37
NO_X	−94,724	−8	−268,075	−29	−380,328	−35
$PM_{2.5}$ [b]	609	2	1,618	8	2,269	9
SO_X	−282	−5	−803	−14	−1,127	−16
VOC	−13,971	−7	−39,383	−22	−55,638	−26

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Positive number means emissions would increase from reference to control case. $PM_{2.5}$ from tire wear and brake wear are included.

(iii) Total Impacts of the Proposed Program and Alternative 4

The following four tables summarize the projected upstream emission impacts of the preferred alternative and Alternative 4 on both criteria pollutants and air toxics from the heavy-duty sector, relative to Alternative 1b and Alternative 1a.

TABLE VIII–9—ANNUAL TOTAL IMPACTS (UPSTREAM AND DOWNSTREAM) OF CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1b USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% reduction	US short tons	% reduction	US short tons	% reduction
1,3-Butadiene	−9	−3	−25	−13	−34	−16
Acetaldehyde	−672	−10	−1,893	−30	−2,682	−36
Acrolein	−97	−10	−273	−31	−387	−37
Benzene	−145	−5	−421	−18	−595	−22
CO	−30,282	−3	−87,286	−8	−123,876	−10
Formaldehyde	−2,119	−11	−5,969	−32	−8,460	−37
NO_X	−101,916	−7	−291,282	−26	−413,501	−31
$PM_{2.5}$	−376	−1	−1,535	−3	−2,199	−4
SO_X	−6,213	−5	−19,905	−14	−28,101	−17
VOC	−16,227	−6	−49,080	−18	−69,525	−22

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VIII–10—ANNUAL TOTAL IMPACTS (UPSTREAM AND DOWNSTREAM) OF CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1b USING ANALYSIS METHOD A [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% reduction	US short tons	% reduction	US short tons	% reduction
1,3-Butadiene	−9	−3	−25	−13	−34	−16
Acetaldehyde	−673	−10	−1,893	−30	−2,682	−36
Acrolein	−97	−10	−273	−31	−387	−37
Benzene	−152	−6	−426	−18	−595	−22
CO	−31,383	−3	−88,047	−8	−124,137	−10
Formaldehyde	−2,123	−11	−5,970	−32	−8,460	−37
NO_X	−105,693	−7	−293,918	−26	−413,967	−31
$PM_{2.5}$	−639	−1	−1,703	−4	−2,237	−4
SO_X	−7,682	−6	−20,849	−15	−28,385	−17

TABLE VIII–10—ANNUAL TOTAL IMPACTS (UPSTREAM AND DOWNSTREAM) OF CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1b USING ANALYSIS METHOD A[a]—Continued

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% reduction	US short tons	% reduction	US short tons	% reduction
VOC	−18,006	−6	−50,189	−19	−69,796	−22

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VIII–11—ANNUAL TOTAL IMPACTS (UPSTREAM AND DOWNSTREAM) OF CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD A[a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% reduction	US short tons	% reduction	US short tons	% reduction
1,3-Butadiene	−9	−3	−25	−13	−35	−16
Acetaldehyde	−672	−10	−1,891	−30	−2,680	−36
Acrolein	−97	−10	−273	−31	−386	−37
Benzene	−145	−5	−425	−18	−603	−22
CO	−30,487	−3	−88,724	−8	−126,081	−10
Formaldehyde	−2,119	−11	−5,969	−32	−8,461	−37
NO_X	−102,983	−7	−299,911	−26	−427,332	−32
$PM_{2.5}$	−419	−1	−1,910	−4	−2,791	−5
SO_X	−6,421	−5	−21,672	−15	−30,850	−18
VOC	−16,403	−6	−50,812	−19	−72,253	−23

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VIII–12—ANNUAL TOTAL IMPACTS (UPSTREAM AND DOWNSTREAM) OF CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD A[a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% reduction	US short tons	% reduction	US short tons	% reduction
1,3-Butadiene	−9	−3	−25	−13	−35	−16
Acetaldehyde	−672	−10	−1,891	−30	−2,679	−36
Acrolein	−97	−10	−273	−31	−386	−37
Benzene	−153	−6	−430	−18	−603	−22
CO	−31,637	−3	−89,514	−8	−126,360	−10
Formaldehyde	−2,123	−11	−5,969	−32	−8,460	−37
NO_X	−106,822	−7	−302,575	−26	−427,805	−32
$PM_{2.5}$	−689	−1	−2,082	−5	−2,833	−5
SO_X	−7,941	−6	−22,646	−16	−31,151	−18
VOC	−18,222	−6	−51,924	−19	−72,509	−23

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(b) Model Year Lifetime Analysis

TABLE VIII–13—LIFETIME NON-GHG REDUCTIONS USING ANALYSIS METHOD A—SUMMARY FOR MODEL YEARS 2018–2029 (US SHORT TONS)[a]

No-action alternative (baseline)	Alternative 3 (proposed)		Alternative 4	
	1b (more dynamic)	1a (less dynamic)	1b (more dynamic)	1a (less dynamic)
NO_X	2,359,548	2,409,738	2,420,931	2,472,021
Downstream	2,103,163	2,137,232	2,130,659	2,164,458

TABLE VIII–13—LIFETIME NON-GHG REDUCTIONS USING ANALYSIS METHOD A—SUMMARY FOR MODEL YEARS 2018–2029 (US SHORT TONS) [a]—Continued

No-action alternative (baseline)	Alternative 3 (proposed)		Alternative 4	
	1b (more dynamic)	1a (less dynamic)	1b (more dynamic)	1a (less dynamic)
Upstream	256,385	272,506	290,272	307,563
$PM_{2.5}$	13,496	15,706	17,524	19,839
Downstream [b]	−14,051	−13,546	−13,649	−13,153
Upstream	27,547	29,252	31,173	32,992
SO_X	167,415	177,948	189,670	200,992
Downstream	5,326	5,562	6,079	6,311
Upstream	162,089	172,386	183,591	194,681

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Negative number means emissions would increase from reference to control case. $PM_{2.5}$ from tire wear and brake wear are included.

(2) Impacts of the Proposed Rules and Alternative 4 using Analysis Method B

(a) Calendar Year Analysis

(i) Upstream Impacts of the Proposed Program and Alternative 4

Increasing efficiency in heavy-duty vehicles would result in reduced fuel demand, and therefore, reductions in the emissions associated with all processes involved in getting petroleum to the pump. To project these impacts, Method B estimated the impact of reduced petroleum volumes on the extraction and transportation of crude oil as well as the production and distribution of finished gasoline and diesel. For the purpose of assessing domestic-only emission reductions, it was necessary to estimate the fraction of fuel savings attributable to domestic finished gasoline and diesel, and of this fuel, what fraction is produced from domestic crude. Method B estimated the emissions associated with production and distribution of gasoline and diesel from crude oil based on emission factors in the ''Greenhouse Gases, Regulated Emissions, and Energy used in Transportation'' model (GREET) developed by DOE's Argonne National Laboratory. In some cases, the GREET values were modified or updated by the agencies to be consistent with the National Emission Inventory (NEI) and emission factors from MOVES. Method B estimated the projected corresponding changes in upstream emissions using the same tools originally created for the Renewable Fuel Standard 2 (RFS2) rulemaking analysis,[409] used in the LD GHG rulemakings,[410] HD GHG Phase 1,[411] and updated for the current analysis. More information on the development of the emission factors used in this analysis can be found in Chapter 5 of the draft RIA.

Table VIII–14 and Table VIII–15 summarizes the projected upstream emission impacts of the Preferred Alternative and Alternative 4 on both criteria pollutants and air toxics from the heavy-duty sector, relative to Alternative 1a. The comparable estimates relative to Alternative 1b are presented in Section VIII. A. (1).

TABLE VIII–14—ANNUAL UPSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD B [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−1	−5.0	−4	−15.3	−5	−18.4
Acetaldehyde	−4	−3.0	−18	−11.9	−26	−14.6
Acrolein	−0.5	−3.4	−2	−12.7	−3	−15.5
Benzene	−24	−3.8	−92	−13.4	−132	−16.3
CO	−3,798	−4.9	−13,001	−15.3	−18,772	−18.4
Formaldehyde	−19	−4.7	−67	−14.9	−98	−18.0
NO_X	−9,282	−4.9	−31,782	−15.3	−45,888	−18.4
$PM_{2.5}$	−1,020	−4.9	−3,514	−15.2	−5,072	−18.2
SO_X	−5,817	−4.9	−19,902	−15.3	−28,736	−18.4
VOC	−3,283	−3.7	−12,724	−13.2	−18,214	−16.1

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[409] U.S. EPA. Draft Regulatory Impact Analysis: Changes to Renewable Fuel Standard Program. Chapters 2 and 3. May 26, 2009. Docket ID: EPA–HQ–OAR–2009–0472–0119.

[410] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards (77 FR 62623, October 15, 2012).

[411] Greenhouse Gas Emission Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (76 FR 57106, September 15, 2011).

TABLE VIII–15—ANNUAL UPSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD B [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−1	−6.1	−4	−15.9	−5	−18.4
Acetaldehyde	−6	−4.3	−20	−12.6	−26	−14.7
Acrolein	−1	−4.7	−2	−13.3	−3	−15.5
Benzene	−32	−5.0	−97	−14.0	−133	−16.3
CO	−4,661	−6.1	−13,485	−15.9	−18,812	−18.4
Formaldehyde	−24	−5.9	−70	−15.5	−97	−18.0
NO_X	−11,393	−6.1	−32,965	−15.9	−45,986	−18.4
$PM_{2.5}$	−1,256	−6.0	−3,647	−15.7	−5,083	−18.3
SO_X	−7,137	−6.1	−20,641	−15.9	−28,797	−18.4
VOC	−4,342	−4.9	−13,326	−13.8	−18,273	−16.1

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(ii) Downstream Impacts of the Proposed Program and Alternative 4

Both the proposed program and Alternative 4 would impact the downstream emissions of non-GHG pollutants. These pollutants include oxides of nitrogen (NO_X), oxides of sulfur (SO_X), volatile organic compounds (VOC), carbon monoxide (CO), fine particulate matter ($PM_{2.5}$), and air toxics. The agencies are expecting reductions in downstream emissions of NO_X, VOC, SO_X, CO, and air toxics. Much of these estimated net reductions are a result of the agencies' anticipation of increased use of auxiliary power units (APUs) in combination tractors during extended idling; APUs emit these pollutants at a lower rate than on-road engines during extended idle operation, with the exception of $PM_{2.5}$. Additional reductions in tailpipe emissions of NO_X and CO and refueling emissions of VOC would be achieved through improvements in engine efficiency and reduced road load (improved aerodynamics and tire rolling resistance), which reduces the amount of work required to travel a given distance and increases fuel economy. For vehicle types not affected by road load improvements, such as HD pickups and vans,[412] non-GHG emissions would increase very slightly due to VMT rebound. In addition, brake wear and tire wear emissions of $PM_{2.5}$ would also increase very slightly due to VMT rebound. The agencies estimate that downstream emissions of SO_X would be reduced, because they are roughly proportional to fuel consumption. Alternative 4 would have directionally similar effects as the preferred alternative.

For vocational vehicles and tractor-trailers, agencies used MOVES to determine non-GHG emissions impacts of the proposed rules and Alternative 4, relative to the less dynamic baseline (Alternative 1a). The improvements in engine efficiency and road load, the increased use of APUs, and VMT rebound were included in the MOVES analysis. For this analysis, Method B also used the MOVES model for HD pickups and vans. (Note that for the comparable analysis as described in Section VIII. A. (1), Method A used DOT's CAFE model). Further information about the modeling using DOT's CAFE and MOVES model is available in Section VII and Chapter 5 of the draft RIA.

The downstream criteria pollutant and air toxics impacts of the Preferred Alternative and Alternative 4, relative to Alternative 1a, are presented in Table VIII–16 and Table VIII–17, respectively.

TABLE VIII–16—ANNUAL DOWNSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD B [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−8	−2.6	−22	−15.1	−31	−19.6
Acetaldehyde	−670	−10.3	−1,884	−31.0	−2,671	−36.5
Acrolein	−97	−9.9	−272	−31.6	−385	−37.3
Benzene	−125	−5.9	−353	−21.0	−501	−25.7
CO	−25,824	−1.7	−72,960	−6.0	−103,887	−7.6
Formaldehyde	−2,102	−11.5	−5,911	−32.1	−8,379	−37.5
NO_X	−93,220	−7.5	−267,125	−29.1	−380,721	−35.2
$PM_{2.5}$ [b]	634	1.6	1,631	7.6	2,257	9.1
SO_X	−254	−4.8	−876	−15.0	−1,264	−18.1
VOC	−13,440	−6.4	−40,148	−21.7	−57,308	−26.1

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.
[b] Positive number means emissions would increase from reference to control case. $PM_{2.5}$ from tire wear and brake wear are included.

[412] HD pickups and vans are subject to gram per mile (distance) emission standards, as opposed to larger heavy-duty vehicles which are certified to a gram per brake horsepower (work) standard.

TABLE VIII–17—ANNUAL DOWNSTREAM IMPACTS ON CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY – DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1aUSING ANALYSIS METHOD B [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−8	−2.6	−22	−15.1	−31	−19.6
Acetaldehyde	−670	−10.3	−1,884	−31.0	−2,671	−36.5
Acrolein	−97	−9.9	−272	−31.6	−385	−37.3
Benzene	−126	−5.9	−354	−21.0	−501	−25.7
CO	−25,919	−1.7	−73,041	−6.0	−103,891	−7.6
Formaldehyde	−2,101	−11.5	−5,910	−32.1	−8,378	−37.5
NO_X	−94,787	−7.6	−268,373	−29.2	−380,810	−35.2
$PM_{2.5}$ [b]	610	1.5	1,611	7.5	2,256	9.1
SO_X	−313	−5.9	−909	−15.6	−1,267	−18.1
VOC	−14,310	−6.8	−40,640	−22.0	−57,348	−26.1

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Positive number means emissions would increase from reference to control case. $PM_{2.5}$ from tire wear and brake wear are included.

As shown in Table VIII–16, a net increase in downstream $PM_{2.5}$ emissions is expected. Although the improvements in engine efficiency and road load are expected to reduce tailpipe emissions of $PM_{2.5}$, the projected increased use [413] of APUs would lead to higher $PM_{2.5}$ emissions that more than offset the reductions from the tailpipe, since engines powering APUs are currently required to meet less stringent PM standards than on-road engines. Therefore, EPA conducted an evaluation of a program that would reduce the unintended consequence of increase in $PM_{2.5}$ emissions from increased APU use by fitting the APU with a diesel particulate filter or having the APU exhaust plumbed into the vehicle's exhaust system upstream of the particulate matter aftertreatment device. Such program requiring additional $PM_{2.5}$ controls on APU could significantly reduce $PM_{2.5}$ emissions, as shown in Table VIII–18 below. For additional details, see Section III.C.3 of the preamble.

TABLE VIII–18—PROJECTED IMPACT ON $PM_{2.5}$ EMISSIONS OF FURTHER $PM_{2.5}$ CONTROL ON APUS—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD B (US SHORT TONS) [a]

CY	Proposed program inventory without further $PM_{2.5}$ control on APUs	Proposed program inventory with further $PM_{2.5}$ control on APUs	Net impact of further $PM_{2.5}$ control on APUs
2035	23,083	19,999	−3,084
2050	26,932	22,588	−4,344

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

It is worth noting that the emission reductions shown in Table VIII–16 are not incremental to the emissions reductions projected in the Phase 1 rulemaking. This is because, as described in Sections III.D.2.a of the preamble, the agencies have revised their assumptions about the adoption rate of APUs. This proposal assumes that without the proposed Phase 2 program (*i.e.,* in the Phase 2 reference case), the APU adoption rate will be 30 percent for model years 2010 and later, which is the value used in the Phase 1 reference case. EPA conducted an analysis to estimate the combined emissions impacts of the Phase 1 and the proposed Phase 2 programs for NO_X, VOC, SO_X and $PM_{2.5}$ in calendar year 2050 using MOVES2014. The results are shown in Table VIII–19. For NO_X and $PM_{2.5}$ only, we estimated the combined Phase 1 and Phase 2 downstream and upstream emissions impacts for calendar year 2025, and project that the two rules combined would reduce NO_X by up to 120,000 tons and $PM_{2.5}$ by up to 2,000 tons in that year. For additional details, see Chapter 5 of the draft RIA.

[413] The projected use of APU during extended idling is presented in Table VII–3 of the preamble.

TABLE VIII–19—COMBINED PHASE 1 AND PHASE 2 ANNUAL DOWNSTREAM IMPACTS ON CRITERIA POLLUTANTS FROM HEAVY-DUTY SECTOR IN CALENDAR YEAR 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD B

[US short tons] [a]

CY	NO_X	VOC	SO_X	$PM_{2.5}$ [b]
2050	−403,915	−69,415	−2,111	1,890

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Positive number reflects an increase in emissions.

(iii) Total Impacts of the Proposed Program and Alternative 4

As shown in Table VIII–20 and Table VIII–21, agencies estimate that both the proposed program and Alternative 4 would result in overall net reductions of NO_X, VOC, SO_X, CO, $PM_{2.5}$, and air toxics emissions. The downstream increase in $PM_{2.5}$ due to APU use is expected to be more than offset by reductions in $PM_{2.5}$ from upstream.[414] The results are shown both in changes in absolute tons and in percent reductions from the less dynamic reference to the alternatives for the heavy-duty sector. By 2050, the total impacts of the proposed program and Alternative 4 on criteria pollutants and air toxics are indistinguishable.

TABLE VIII–20—ANNUAL TOTAL IMPACTS (UPSTREAM AND DOWNSTREAM) OF CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—PREFERRED ALTERNATIVE VS. ALT 1a USING ANALYSIS METHOD B [a]

Pollutant	CY2025		CY2035		CY2050	
	% Reduction	US short tons	% Reduction	US short tons	% Reduction	US short tons
1,3-Butadiene	−9	−2.7	−25	−15.1	−36	−19.4
Acetaldehyde	−674	−10.1	−1,902	−30.5	−2,697	−36.0
Acrolein	−97	−9.8	−274	−31.3	−388	−36.9
Benzene	−149	−5.4	−445	−18.8	−633	−22.9
CO	−29,622	−1.9	−85,961	−6.6	−122,659	−8.4
Formaldehyde	−2,121	−11.4	−5,978	−31.7	−8,475	−37.0
NO_X	−102,502	−7.2	−298,907	−26.6	−426,610	−32.1
$PM_{2.5}$	−386	−0.6	−1,883	−4.2	−2,815	−5.4
SO_X	−6,070	−4.9	−20,777	−15.3	−30,000	−18.4
VOC	−16,724	−5.6	−52,872	−18.8	−75,521	−22.7

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE VIII–21—ANNUAL TOTAL IMPACTS (UPSTREAM AND DOWNSTREAM) OF CRITERIA POLLUTANTS AND AIR TOXICS FROM HEAVY-DUTY SECTOR IN CALENDAR YEARS 2025, 2035 AND 2050—ALTERNATIVE 4 VS. ALT 1a USING ANALYSIS METHOD B [a]

Pollutant	CY2025		CY2035		CY2050	
	US short tons	% Reduction	US short tons	% Reduction	US short tons	% Reduction
1,3-Butadiene	−9	−2.8	−26	−15.2	−36	−19.4
Acetaldehyde	−676	−10.1	−1,903	−30.6	−2,697	−36.0
Acrolein	−97	−9.8	−274	−31.3	−388	−36.9
Benzene	−157	−5.7	−450	−18.9	−634	−22.9
CO	−30,580	−1.9	−86,526	−6.6	−122,703	−8.4
Formaldehyde	−2,125	−11.4	−5,980	−31.7	−8,476	−37.0
NO_X	−106,180	−7.4	−301,339	−26.8	−426,796	−32.1
$PM_{2.5}$	−646	−1.1	−2,036	−4.6	−2,827	−5.4
SO_X	−7,450	−6.1	−21,550	−15.9	−30,064	−18.4
VOC	−18,652	−6.2	−53,966	−19.2	−75,621	−22.7

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[414] Although net reduction in $PM_{2.5}$ is expected at the national level, it is unlikely that the geographic location of increases in downstream $PM_{2.5}$ emissions will coincide with the location of decreases in upstream $PM_{2.5}$ emissions. For further details, see Section VIII.D of this preamble and in Chapter 8 of the draft RIA.

(b) Model Year Lifetime Analysis

In addition to the annual non-GHG emissions reductions expected from the proposed rules and Alternative 4, the combined (downstream and upstream) non-GHG impacts for the lifetime of the impacted vehicles were estimated. Table VIII–22 shows the fleet-wide reductions of NO_X, $PM_{2.5}$ and SO_X from the preferred alternative and Alternative 4, relative to Alternative 1a, through the lifetime[415] of heavy-duty vehicles. For the lifetime non-GHG reductions by vehicle categories, see Chapter 5 of the draft RIA.

TABLE VIII–22—LIFETIME NON-GHG REDUCTIONS USING ANALYSIS METHOD B—SUMMARY FOR MODEL YEARS 2018–2029

[US short tons][a]

No–action alternative (baseline)	Alternative 3 (proposed)	Alternative 4
	1a (Less dynamic)	1a (Less dynamic)
NO_X	2,399,990	2,459,497
Downstream	2,139,331	2,167,512
Upstream	260,659	291,986
$PM_{2.5}$	15,206	19,151
Downstream[b]	−13,528	−13,089
Upstream	28,733	32,240
SO_X	169,436	189,904
Downstream	6,158	7,035
Upstream	163,278	182,869

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Negative number means emissions would increase from reference to control case. $PM_{2.5}$ from tire wear and brake wear are included.

B. Health Effects of Non-GHG Pollutants

In this section, we discuss health effects associated with exposure to some of the criteria and air toxic pollutants impacted by the proposed and alternative heavy-duty vehicle standards.

(1) Particulate Matter

(a) Background

Particulate matter is a highly complex mixture of solid particles and liquid droplets distributed among numerous atmospheric gases which interact with solid and liquid phases. Particles range in size from those smaller than 1 nanometer (10^{-9} meter) to over 100 micrometer (μm, or 10^{-6} meter) in diameter (for reference, a typical strand of human hair is 70 μm in diameter and a grain of salt is about 100 μm). Atmospheric particles can be grouped into several classes according to their aerodynamic and physical sizes. Generally, the three broad classes of particles considered by EPA include ultrafine particles (UFP, aerodynamic diameter <0.1 μm), ''fine'' particles ($PM_{2.5}$; particles with a nominal mean aerodynamic diameter less than or equal to 2.5 μm), and ''thoracic'' particles (PM_{10}; particles with a nominal mean aerodynamic diameter less than or equal to 10 μm).[416] Particles that fall within the size range between $PM_{2.5}$ and PM_{10}, are referred to as ''thoracic coarse particles'' ($PM_{10-2.5}$, particles with a nominal mean aerodynamic diameter less than or equal to 10 μm and greater than 2.5 μm). EPA currently has standards that regulate $PM_{2.5}$ and PM_{10}.[417]

Particles span many sizes and shapes and may consist of hundreds of different chemicals. Particles are emitted directly from sources and are also formed through atmospheric chemical reactions; the former are often referred to as ''primary'' particles, and the latter as ''secondary'' particles. Particle concentration and composition varies by time of year and location, and in addition to differences in source emissions, is affected by several weather-related factors, such as temperature, clouds, humidity, and wind. A further layer of complexity comes from particles' ability to shift between solid/liquid and gaseous phases, which is influenced by concentration and meteorology, especially temperature.

Fine particles are produced primarily by combustion processes and by transformations of gaseous emissions (*e.g.,* sulfur oxides (SO_X), oxides of nitrogen, and volatile organic compounds (VOC)) in the atmosphere. The chemical and physical properties of $PM_{2.5}$ may vary greatly with time, region, meteorology, and source category. Thus, $PM_{2.5}$ may include a complex mixture of different components including sulfates, nitrates, organic compounds, elemental carbon and metal compounds. These particles can remain in the atmosphere for days to weeks and travel hundreds to thousands of kilometers.

(b) Health Effects of PM

Scientific studies show ambient PM is associated with a broad range of health effects. These health effects are discussed in detail in the December 2009 Integrated Science Assessment for Particulate Matter (PM ISA).[418] The PM ISA summarizes health effects evidence associated with both short- and long-term exposures to $PM_{2.5}$, $PM_{10-2.5}$, and ultrafine particles. The PM ISA concludes that human exposures to ambient $PM_{2.5}$ concentrations are associated with a number of adverse health effects and characterizes the weight of evidence for these health

[415] A lifetime of 30 years is assumed in MOVES.

[416] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F. Figure 3–1.

[417] Regulatory definitions of PM size fractions, and information on reference and equivalent methods for measuring PM in ambient air, are provided in 40 CFR parts 50, 53, and 58. With regard to national ambient air quality standards (NAAQS) which provide protection against health and welfare effects, the 24-hour PM_{10} standard provides protection against effects associated with short-term exposure to thoracic coarse particles (*i.e.,* $PM_{10-2.5}$).

[418] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F.

outcomes.[419] The discussion below highlights the PM ISA's conclusions pertaining to health effects associated with both short- and long-term PM exposures. Further discussion of health effects associated with $PM_{2.5}$ can also be found in the rulemaking documents for the most recent review of the PM NAAQS completed in 2012.[420] [421]

EPA has concluded that a causal relationship exists between both long- and short-term exposures to $PM_{2.5}$ and premature mortality and cardiovascular effects and a likely causal relationship exists between long- and short-term $PM_{2.5}$ exposures and respiratory effects. Further, there is evidence suggestive of a causal relationship between long-term $PM_{2.5}$ exposures and other health effects, including developmental and reproductive effects (*e.g.,* low birth weight, infant mortality) and carcinogenic, mutagenic, and genotoxic effects (*e.g.,* lung cancer mortality).[422]

As summarized in the Final PM NAAQS rule, and discussed extensively in the 2009 p.m. ISA, the available scientific evidence significantly strengthens the link between long- and short-term exposure to $PM_{2.5}$ and premature mortality, while providing indications that the magnitude of the $PM_{2.5}$- mortality association with long-term exposures may be larger than previously estimated. [423] [424] The strongest evidence comes from recent studies investigating long-term exposure to $PM_{2.5}$ and cardiovascular-related mortality. The evidence supporting a causal relationship between long-term $PM_{2.5}$ exposure and mortality also includes consideration of new studies that demonstrated an improvement in community health following reductions in ambient fine particles.

Several studies evaluated in the 2009 p.m. ISA have examined the association between cardiovascular effects and long-term $PM_{2.5}$ exposures in multi-city epidemiological studies conducted in the U.S. and Europe. These studies have provided new evidence linking long-term exposure to $PM_{2.5}$ with an array of cardiovascular effects such as heart attacks, congestive heart failure, stroke, and mortality. This evidence is coherent with studies of effects associated with short-term exposure to $PM_{2.5}$ that have observed associations with a continuum of effects ranging from subtle changes in indicators of cardiovascular health to serious clinical events, such as increased hospitalizations and emergency department visits due to cardiovascular disease and cardiovascular mortality.[425]

As detailed in the 2009 p.m. ISA, extended analyses of seminal epidemiological studies, as well as more recent epidemiological studies conducted in the U.S. and abroad, provide strong evidence of respiratory-related morbidity effects associated with long-term $PM_{2.5}$ exposure. The strongest evidence for respiratory-related effects is from studies that evaluated decrements in lung function growth (in children), increased respiratory symptoms, and asthma development. The strongest evidence from short-term $PM_{2.5}$ exposure studies has been observed for increased respiratory-related emergency department visits and hospital admissions for chronic obstructive pulmonary disease (COPD) and respiratory infections.[426]

The body of scientific evidence detailed in the 2009 p.m. ISA is still limited with respect to associations between long-term $PM_{2.5}$ exposures and developmental and reproductive effects as well as cancer, mutagenic, and genotoxic effects. The strongest evidence for an association between $PM_{2.5}$ and developmental and reproductive effects comes from epidemiological studies of low birth weight and infant mortality, especially due to respiratory causes during the post-neonatal period (*i.e.,* 1 month to 12 months of age).[427] With regard to cancer effects, ''[m]ultiple epidemiologic studies have shown a consistent positive association between $PM_{2.5}$ and lung cancer mortality, but studies have generally not reported associations between $PM_{2.5}$ and lung cancer incidence.'' [428]

Specific groups within the general population are at increased risk for experiencing adverse health effects related to PM exposures.[429] [430] [431] [432] The evidence detailed in the 2009 p.m. ISA expands our understanding of previously identified at-risk populations and lifestages (*i.e.,* children, older adults, and individuals with pre-existing heart and lung disease) and supports the identification of additional at-risk populations (*e.g.,* persons with lower socioeconomic status, genetic differences). Additionally, there is emerging, though still limited, evidence for additional potentially at-risk populations and lifestages, such as those with diabetes, people who are obese, pregnant women, and the developing fetus.[433]

For $PM_{10-2.5}$, the 2009 p.m. ISA concluded that available evidence was suggestive of a causal relationship between short-term exposures to $PM_{10-2.5}$ and cardiovascular effects (*e.g.,* hospital admissions and ED visits, changes in cardiovascular function), respiratory effects (*e.g.,* ED visits and hospital admissions, increase in markers of pulmonary inflammation), and premature mortality. Data were inadequate to draw conclusions regarding the relationships between long-term exposure to $PM_{10-2.5}$ and various health effects.[434] [435] [436]

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[419] The causal framework draws upon the assessment and integration of evidence from across epidemiological, controlled human exposure, and toxicological studies, and the related uncertainties that ultimately influence our understanding of the evidence. This framework employs a five-level hierarchy that classifies the overall weight of evidence and causality using the following categorizations: causal relationship, likely to be causal relationship, suggestive of a causal relationship, inadequate to infer a causal relationship, and not likely to be a causal relationship (U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, Table 1–3).

[420] 78 FR 3103–3104, January 15, 2013.

[421] 77 FR 38906–38911, June 29, 2012.

[422] These causal inferences are based not only on the more expansive epidemiological evidence available in this review but also reflect consideration of important progress that has been made to advance our understanding of a number of potential biologic modes of action or pathways for PM-related cardiovascular and respiratory effects (U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, Chapter 5).

[423] 78 FR 3103–3104, January 15, 2013.

[424] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, Chapter 6 (Section 6.5) and Chapter 7 (Section 7.6).

[425] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, Chapter 2 (Section 2.3.1 and 2.3.2) and Chapter 6.

[426] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, Chapter 2 (Section 2.3.1 and 2.3.2) and Chapter 6.

[427] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, Chapter 2 (Section 2.3.1 and 2.3.2) and Chapter 7.

[428] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F. pg 2–13

[429] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F. Chapter 8 and Chapter 2.

[430] 77 FR 38890, June 29, 2012.

[431] 78 FR 3104, January 15, 2013.

[432] U.S. EPA. (2011). Policy Assessment for the Review of the PM NAAQS. U.S. Environmental Protection Agency, Washington, DC, EPA/452/R–11–003. Section 2.2.1.

[433] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F. Chapter 8 and Chapter 2 (Section 2.4.1).

[434] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report).

For ultrafine particles, the 2009 p.m. ISA concluded that the evidence was suggestive of a causal relationship between short-term exposures and cardiovascular effects, including changes in heart rhythm and vasomotor function (the ability of blood vessels to expand and contract). It also concluded that there was evidence suggestive of a causal relationship between short-term exposure to ultrafine particles and respiratory effects, including lung function and pulmonary inflammation, with limited and inconsistent evidence for increases in ED visits and hospital admissions. Data were inadequate to draw conclusions regarding the relationship between short-term exposure to ultrafine particle and additional health effects including premature mortality as well as long-term exposure to ultrafine particles and all health outcomes evaluated.[437] [438]

(2) Ozone

(a) Background

Ground-level ozone pollution is typically formed through reactions involving VOC and NO_X in the lower atmosphere in the presence of sunlight. These pollutants, often referred to as ozone precursors, are emitted by many types of pollution sources, such as highway and nonroad motor vehicles and engines, power plants, chemical plants, refineries, makers of consumer and commercial products, industrial facilities, and smaller area sources.

The science of ozone formation, transport, and accumulation is complex. Ground-level ozone is produced and destroyed in a cyclical set of chemical reactions, many of which are sensitive to temperature and sunlight. When ambient temperatures and sunlight levels remain high for several days and the air is relatively stagnant, ozone and its precursors can build up and result in more ozone than typically occurs on a single high-temperature day. Ozone and its precursors can be transported hundreds of miles downwind from precursor emissions, resulting in elevated ozone levels even in areas with low local VOC or NO_X emissions.

U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F. Section 2.3.4 and Table 2–6.

[435] 78 FR 3167–3168, January 15, 2013.

[436] 77 FR 38947–38951, June 29, 2012.

[437] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F. Section 2.3.5 and Table 2–6.

[438] 78 FR 3121, January 15, 2013.

(b) Health Effects of Ozone

This section provides a summary of the health effects associated with exposure to ambient concentrations of ozone.[439] The information in this section is based on the information and conclusions in the February 2013 Integrated Science Assessment for Ozone (Ozone ISA).[440] The Ozone ISA concludes that human exposures to ambient concentrations of ozone are associated with a number of adverse health effects and characterizes the weight of evidence for these health effects.[441] The discussion below highlights the Ozone ISA's conclusions pertaining to health effects associated with both short-term and long-term periods of exposure to ozone.

For short-term exposure to ozone, the Ozone ISA concludes that respiratory effects, including lung function decrements, pulmonary inflammation, exacerbation of asthma, respiratory-related hospital admissions, and mortality, are causally associated with ozone exposure. It also concludes that cardiovascular effects, including decreased cardiac function and increased vascular disease, and total mortality are likely to be causally associated with short-term exposure to ozone and that evidence is suggestive of a causal relationship between central nervous system effects and short-term exposure to ozone.

For long-term exposure to ozone, the Ozone ISA concludes that respiratory effects, including new onset asthma, pulmonary inflammation and injury, are likely to be causally related with ozone exposure. The Ozone ISA characterizes the evidence as suggestive of a causal relationship for associations between long-term ozone exposure and cardiovascular effects, reproductive and developmental effects, central nervous system effects and total mortality. The evidence is inadequate to infer a causal relationship between chronic ozone exposure and increased risk of lung cancer.

Finally, interindividual variation in human responses to ozone exposure can result in some groups being at increased risk for detrimental effects in response to exposure. The Ozone ISA identified several groups that are at increased risk for ozone-related health effects. These groups are people with asthma, children and older adults, individuals with reduced intake of certain nutrients (*i.e.,* Vitamins C and E), outdoor workers, and individuals having certain genetic variants related to oxidative metabolism or inflammation. Ozone exposure during childhood can have lasting effects through adulthood. Such effects include altered function of the respiratory and immune systems. Children absorb higher doses (normalized to lung surface area) of ambient ozone, compared to adults, due to their increased time spent outdoors, higher ventilation rates relative to body size, and a tendency to breathe a greater fraction of air through the mouth. Children also have a higher asthma prevalence compared to adults. Additional children's vulnerability and susceptibility factors are listed in Section XIV.

(3) Nitrogen Oxides

(a) Background

Nitrogen dioxide (NO_2) is a member of the NO_X family of gases. Most NO_2 is formed in the air through the oxidation of nitric oxide (NO) emitted when fuel is burned at a high temperature. NO_2 and its gas phase oxidation products can dissolve in water droplets and further oxidize to form nitric acid which reacts with ammonia to form nitrates, which are important components of ambient PM. The health effects of ambient PM are discussed in Section VIII.B.1.b of this preamble. NO_X and VOC are the two major precursors of ozone. The health effects of ozone are covered in Section VIII.B.2.b.

(b) Health Effects of Nitrogen Oxides

The most recent review of the health effects of oxides of nitrogen completed by EPA can be found in the 2008 Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (Oxides of Nitrogen ISA).[442] EPA concluded that the findings of epidemiological, controlled human exposure, and animal toxicological

[439] Human exposure to ozone varies over time due to changes in ambient ozone concentration and because people move between locations which have notable different ozone concentrations. Also, the amount of ozone delivered to the lung is not only influenced by the ambient concentrations but also by the individuals breathing route and rate.

[440] U.S. EPA. Integrated Science Assessment of Ozone and Related Photochemical Oxidants (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–10/076F, 2013. The ISA is available at *http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492#Download.*

[441] The ISA evaluates evidence and draws conclusions on the causal relationship between relevant pollutant exposures and health effects, assigning one of five ''weight of evidence'' determinations: causal relationship, likely to be a causal relationship, suggestive of a causal relationship, inadequate to infer a causal relationship, and not likely to be a causal relationship. For more information on these levels of evidence, please refer to Table II in the Preamble of the ISA.

[442] U.S. EPA (2008). *Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (Final Report).* EPA/600/R–08/071. Washington, DC: U.S. EPA.

studies provided evidence that was sufficient to infer a likely causal relationship between respiratory effects and short-term NO_2 exposure. The 2008 ISA for Oxides of Nitrogen concluded that the strongest evidence for such a relationship comes from epidemiological studies of respiratory effects including increased respiratory symptoms, emergency department visits, and hospital admissions. Based on both short- and long-term exposure studies, the 2008 ISA for Oxides of Nitrogen concluded that individuals with preexisting pulmonary conditions (*e.g.,* asthma or COPD), children, and older adults are potentially at greater risk of NO_2-related respiratory effects. Based on findings from controlled human exposure studies, the 2008 ISA for Oxides of Nitrogen also drew two broad conclusions regarding airway responsiveness following NO_2 exposure. First, the ISA concluded that NO_2 exposure may enhance the sensitivity to allergen-induced decrements in lung function and increase the allergen-induced airway inflammatory response following 30-minute exposures of asthmatic adults to NO_2 concentrations as low as 260 ppb.[443] Second, exposure to NO_2 was found to enhance the inherent responsiveness of the airway to subsequent nonspecific challenges in controlled human exposure studies of healthy and asthmatic adults. Statistically significant increases in nonspecific airway responsiveness were reported for asthmatic adults following 30-minute exposures to 200–300 ppb NO_2 and following 1-hour exposures to 100 ppb NO_2.[444] Enhanced airway responsiveness could have important clinical implications for asthmatics since transient increases in airway responsiveness following NO_2 exposure have the potential to increase symptoms and worsen asthma control. Together, the epidemiological and experimental data sets formed a plausible, consistent, and coherent description of a relationship between NO_2 exposures and an array of adverse health effects that range from the onset of respiratory symptoms to hospital admissions and emergency department visits for respiratory causes, especially asthma.[445]

In evaluating a broader range of health effects, the 2008 ISA for Oxides of Nitrogen concluded evidence was ''suggestive but not sufficient to infer a causal relationship'' between short-term NO_2 exposure and premature mortality and between long-term NO_2 exposure and respiratory effects. The latter was based largely on associations observed between long-term NO_2 exposure and decreases in lung function growth in children. Furthermore, the 2008 ISA for Oxides of Nitrogen concluded that evidence was ''inadequate to infer the presence or absence of a causal relationship'' between short-term NO_2 exposure and cardiovascular effects as well as between long-term NO_2 exposure and cardiovascular effects, reproductive and developmental effects, premature mortality, and cancer.[446] The conclusions for these health effect categories were informed by uncertainties in the evidence base such as the independent effects of NO_2 exposure within the broader mixture of traffic-related pollutants, limited evidence from experimental studies, and/or an overall limited literature base.

(4) Sulfur Oxides

(a) Background

Sulfur dioxide (SO_2), a member of the sulfur oxide (SO_X) family of gases, is formed from burning fuels containing sulfur (*e.g.,* coal or oil derived), extracting gasoline from oil, or extracting metals from ore. SO_2 and its gas phase oxidation products can dissolve in water droplets and further oxidize to form sulfuric acid which reacts with ammonia to form sulfates, which are important components of ambient PM. The health effects of ambient PM are discussed in Section VIII.B.1.b of this preamble.

(b) Health Effects of SO_2

Information on the health effects of SO_2 can be found in the 2008 Integrated Science Assessment for Sulfur Oxides—Health Criteria (SO_X ISA).[447] Short-term peaks of SO_2 have long been known to cause adverse respiratory health effects, particularly among individuals with asthma. In addition to those with asthma (both children and adults), potentially sensitive groups include all children and the elderly. During periods of elevated ventilation, asthmatics may experience symptomatic bronchoconstriction within minutes of exposure. Following an extensive evaluation of health evidence from epidemiologic and laboratory studies, EPA concluded that there is a causal relationship between respiratory health effects and short-term exposure to SO_2. Separately, based on an evaluation of the epidemiologic evidence of associations between short-term exposure to SO_2 and mortality, EPA concluded that the overall evidence is suggestive of a causal relationship between short-term exposure to SO_2 and mortality. Additional information on the health effects of SO_2 is available in Chapter 6.1.1.4.2 of the RIA.

(5) Carbon Monoxide

(a) Background

Carbon monoxide (CO) is a colorless, odorless gas emitted from combustion processes. Nationally and, particularly in urban areas, the majority of CO emissions to ambient air come from mobile sources.

(b) Health Effects of Carbon Monoxide

Information on the health effects of CO can be found in the January 2010 Integrated Science Assessment for Carbon Monoxide (CO ISA).[448] The CO ISA concludes that ambient concentrations of CO are associated with a number of adverse health effects.[449] This section provides a summary of the health effects associated with exposure to ambient concentrations of CO.[450]

Controlled human exposure studies of subjects with coronary artery disease show a decrease in the time to onset of exercise-induced angina (chest pain) and electrocardiogram changes following CO exposure. In addition, epidemiologic studies show associations between short-term CO exposure and

[443] U.S. EPA (2008). Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (Final Report). EPA/600/R–08/071. Washington, DC: U.S. EPA, Section 3.1.3.1.

[444] U.S. EPA (2008). Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (Final Report). EPA/600/R–08/071. Washington, DC: U.S.EPA, Section 3.1.3.2.

[445] U.S. EPA (2008). Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (Final Report). EPA/600/R–08/071. Washington, DC: U.S. EPA, Section 3.1.7.

[446] U.S. EPA (2008). Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (Final Report). EPA/600/R–08/071. Washington, DC: U.S. EPA.

[447] U.S. EPA. (2008). *Integrated Science Assessment (ISA) for Sulfur Oxides—Health Criteria (Final Report).* EPA/600/R–08/047F. Washington, DC: U.S. Environmental Protection Agency.

[448] U.S. EPA, (2010). Integrated Science Assessment for Carbon Monoxide (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–09/019F, 2010. Available at *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=218686.*

[449] The ISA evaluates the health evidence associated with different health effects, assigning one of five ''weight of evidence'' determinations: causal relationship, likely to be a causal relationship, suggestive of a causal relationship, inadequate to infer a causal relationship, and not likely to be a causal relationship. For definitions of these levels of evidence, please refer to Section 1.6 of the ISA.

[450] Personal exposure includes contributions from many sources, and in many different environments. Total personal exposure to CO includes both ambient and nonambient components; and both components may contribute to adverse health effects.

cardiovascular morbidity, particularly increased emergency room visits and hospital admissions for coronary heart disease (including ischemic heart disease, myocardial infarction, and angina). Some epidemiologic evidence is also available for increased hospital admissions and emergency room visits for congestive heart failure and cardiovascular disease as a whole. The CO ISA concludes that a causal relationship is likely to exist between short-term exposures to CO and cardiovascular morbidity. It also concludes that available data are inadequate to conclude that a causal relationship exists between long-term exposures to CO and cardiovascular morbidity.

Animal studies show various neurological effects with in-utero CO exposure. Controlled human exposure studies report central nervous system and behavioral effects following low-level CO exposures, although the findings have not been consistent across all studies. The CO ISA concludes the evidence is suggestive of a causal relationship with both short- and long-term exposure to CO and central nervous system effects.

A number of studies cited in the CO ISA have evaluated the role of CO exposure in birth outcomes such as preterm birth or cardiac birth defects. The epidemiologic studies provide limited evidence of a CO-induced effect on preterm births and birth defects, with weak evidence for a decrease in birth weight. Animal toxicological studies have found perinatal CO exposure to affect birth weight, as well as other developmental outcomes. The CO ISA concludes the evidence is suggestive of a causal relationship between long-term exposures to CO and developmental effects and birth outcomes.

Epidemiologic studies provide evidence of associations between ambient CO concentrations and respiratory morbidity such as changes in pulmonary function, respiratory symptoms, and hospital admissions. A limited number of epidemiologic studies considered copollutants such as ozone, SO_2, and PM in two-pollutant models and found that CO risk estimates were generally robust, although this limited evidence makes it difficult to disentangle effects attributed to CO itself from those of the larger complex air pollution mixture. Controlled human exposure studies have not extensively evaluated the effect of CO on respiratory morbidity. Animal studies at levels of 50–100 ppm CO show preliminary evidence of altered pulmonary vascular remodeling and oxidative injury. The CO ISA concludes that the evidence is suggestive of a causal relationship between short-term CO exposure and respiratory morbidity, and inadequate to conclude that a causal relationship exists between long-term exposure and respiratory morbidity.

Finally, the CO ISA concludes that the epidemiologic evidence is suggestive of a causal relationship between short-term concentrations of CO and mortality. Epidemiologic studies provide evidence of an association between short-term exposure to CO and mortality, but limited evidence is available to evaluate cause-specific mortality outcomes associated with CO exposure. In addition, the attenuation of CO risk estimates which was often observed in copollutant models contributes to the uncertainty as to whether CO is acting alone or as an indicator for other combustion-related pollutants. The CO ISA also concludes that there is not likely to be a causal relationship between relevant long-term exposures to CO and mortality.

(6) Diesel Exhaust

(a) Background

Diesel exhaust consists of a complex mixture composed of carbon dioxide, oxygen, nitrogen, water vapor, carbon monoxide, nitrogen compounds, sulfur compounds and numerous low-molecular-weight hydrocarbons. A number of these gaseous hydrocarbon components are individually known to be toxic, including aldehydes, benzene and 1,3-butadiene. The diesel particulate matter present in diesel exhaust consists mostly of fine particles (< 2.5 µm), of which a significant fraction is ultrafine particles (< 0.1 µm). These particles have a large surface area which makes them an excellent medium for adsorbing organics and their small size makes them highly respirable. Many of the organic compounds present in the gases and on the particles, such as polycyclic organic matter, are individually known to have mutagenic and carcinogenic properties.

Diesel exhaust varies significantly in chemical composition and particle sizes between different engine types (heavy-duty, light-duty), engine operating conditions (idle, accelerate, decelerate), and fuel formulations (high/low sulfur fuel). Also, there are emissions differences between on-road and nonroad engines because the nonroad engines are generally of older technology. After being emitted in the engine exhaust, diesel exhaust undergoes dilution as well as chemical and physical changes in the atmosphere. The lifetime for some of the compounds present in diesel exhaust ranges from hours to days.

(b) Health Effects of Diesel Exhaust

In EPA's 2002 Diesel Health Assessment Document (Diesel HAD), exposure to diesel exhaust was classified as likely to be carcinogenic to humans by inhalation from environmental exposures, in accordance with the revised draft 1996/1999 EPA cancer guidelines.[451] [452] A number of other agencies (National Institute for Occupational Safety and Health, the International Agency for Research on Cancer, the World Health Organization, California EPA, and the U.S. Department of Health and Human Services) had made similar hazard classifications prior to 2002. EPA also concluded in the 2002 Diesel HAD that it was not possible to calculate a cancer unit risk for diesel exhaust due to limitations in the exposure data for the occupational groups or the absence of a dose-response relationship.

In the absence of a cancer unit risk, the Diesel HAD sought to provide additional insight into the significance of the diesel exhaust cancer hazard by estimating possible ranges of risk that might be present in the population. An exploratory analysis was used to characterize a range of possible lung cancer risk. The outcome was that environmental risks of cancer from long-term diesel exhaust exposures could plausibly range from as low as 10^{-5} to as high as 10^{-3}. Because of uncertainties, the analysis acknowledged that the risks could be lower than 10_{-5}, and a zero risk from diesel exhaust exposure could not be ruled out.

Non-cancer health effects of acute and chronic exposure to diesel exhaust emissions are also of concern to EPA. EPA derived a diesel exhaust reference concentration (RfC) from consideration of four well-conducted chronic rat inhalation studies showing adverse pulmonary effects. The RfC is 5 µg/m^3 for diesel exhaust measured as diesel particulate matter. This RfC does not consider allergenic effects such as those associated with asthma or immunologic or the potential for cardiac effects. There was emerging evidence in 2002, discussed in the Diesel HAD, that

[451] U.S. EPA. (1999). *Guidelines for Carcinogen Risk Assessment.* Review Draft. NCEA–F–0644, July. Washington, DC: U.S. EPA. Retrieved on March 19, 2009 from *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54932*.

[452] U.S. EPA (2002). *Health Assessment Document for Diesel Engine Exhaust.* EPA/600/8–90/057F Office of Research and Development, Washington DC. Retrieved on March 17, 2009 from *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060*. pp. 1–1 1–2.

exposure to diesel exhaust can exacerbate these effects, but the exposure-response data were lacking at that time to derive an RfC based on these then emerging considerations. EPA Diesel HAD states, ''With [diesel particulate matter] being a ubiquitous component of ambient PM, there is an uncertainty about the adequacy of the existing [diesel exhaust] noncancer database to identify all of the pertinent [diesel exhaust]-caused noncancer health hazards.'' The Diesel HAD also notes ''that acute exposure to [diesel exhaust] has been associated with irritation of the eye, nose, and throat, respiratory symptoms (cough and phlegm), and neurophysiological symptoms such as headache, lightheadedness, nausea, vomiting, and numbness or tingling of the extremities.'' The Diesel HAD noted that the cancer and noncancer hazard conclusions applied to the general use of diesel engines then on the market and as cleaner engines replace a substantial number of existing ones, the applicability of the conclusions would need to be reevaluated.

It is important to note that the Diesel HAD also briefly summarizes health effects associated with ambient PM and discusses EPA's then-annual $PM_{2.5}$ NAAQS of 15 μg/m³. In 2012, EPA revised the annual $PM_{2.5}$ NAAQS to 12 μg/m³. There is a large and extensive body of human data showing a wide spectrum of adverse health effects associated with exposure to ambient PM, of which diesel exhaust is an important component. The $PM_{2.5}$ NAAQS is designed to provide protection from the noncancer health effects and premature mortality attributed to exposure to $PM_{2.5}$. The contribution of diesel PM to total ambient PM varies in different regions of the country and also, within a region, from one area to another. The contribution can be high in near-roadway environments, for example, or in other locations where diesel engine use is concentrated.

Since 2002, several new studies have been published which continue to report increased lung cancer risk with occupational exposure to diesel exhaust from older engines. Of particular note since 2011 are three new epidemiology studies which have examined lung cancer in occupational populations, for example, truck drivers, underground nonmetal miners and other diesel motor related occupations. These studies reported increased risk of lung cancer with exposure to diesel exhaust with evidence of positive exposure-response relationships to varying degrees.[453] [454] [455] These newer studies (along with others that have appeared in the scientific literature) add to the evidence EPA evaluated in the 2002 Diesel HAD and further reinforces the concern that diesel exhaust exposure likely poses a lung cancer hazard. The findings from these newer studies do not necessarily apply to newer technology diesel engines since the newer engines have large reductions in the emission constituents compared to older technology diesel engines.

In light of the growing body of scientific literature evaluating the health effects of exposure to diesel exhaust, in June 2012 the World Health Organization's International Agency for Research on Cancer (IARC), a recognized international authority on the carcinogenic potential of chemicals and other agents, evaluated the full range of cancer related health effects data for diesel engine exhaust. IARC concluded that diesel exhaust should be regarded as ''carcinogenic to humans.'' [456] This designation was an update from its 1988 evaluation that considered the evidence to be indicative of a ''probable human carcinogen.''

(7) Air Toxics

(a) Background

Heavy-duty vehicle emissions contribute to ambient levels of air toxics known or suspected as human or animal carcinogens, or that have noncancer health effects. The population experiences an elevated risk of cancer and other noncancer health effects from exposure to the class of pollutants known collectively as ''air toxics.'' [457] These compounds include, but are not limited to, benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, polycyclic organic matter, and naphthalene. These compounds were identified as national or regional risk drivers or contributors in the 2005 National-scale Air Toxics Assessment and have significant inventory contributions from mobile sources.[458]

(b) Benzene

EPA's Integrated Risk Information System (IRIS) database lists benzene as a known human carcinogen (causing leukemia) by all routes of exposure, and concludes that exposure is associated with additional health effects, including genetic changes in both humans and animals and increased proliferation of bone marrow cells in mice.[459] [460] [461] EPA states in its IRIS database that data indicate a causal relationship between benzene exposure and acute lymphocytic leukemia and suggest a relationship between benzene exposure and chronic non-lymphocytic leukemia and chronic lymphocytic leukemia. EPA's IRIS documentation for benzene also lists a range of 2.2×10^{-6} to 7.8×10^{-6} as the unit risk estimate (URE) for benzene.[462] [463] The International Agency for Research on Carcinogens (IARC) has determined that benzene is a human carcinogen and the U.S. Department of Health and Human Services (DHHS) has characterized benzene as a known human carcinogen.[464] [465]

A number of adverse noncancer health effects including blood disorders, such as pre leukemia and aplastic anemia, have also been associated with long-term exposure to benzene.[466] [467]

[453] Garshick, Eric, Francine Laden, Jaime E. Hart, Mary E. Davis, Ellen A. Eisen, and Thomas J. Smith. 2012. Lung cancer and elemental carbon exposure in trucking industry workers. Environmental Health Perspectives 120(9): 1301–1306.

[454] Silverman, D.T., Samanic, C.M., Lubin, J.H., Blair, A.E., Stewart, P.A., Vermeulen, R., & Attfield, M.D. (2012). The diesel exhaust in miners study: A nested case–control study of lung cancer and diesel exhaust. Journal of the National Cancer Institute.

[455] Olsson, Ann C., et al. ''Exposure to diesel motor exhaust and lung cancer risk in a pooled analysis from case-control studies in Europe and Canada.'' American journal of respiratory and critical care medicine 183.7 (2011): 941–948.

[456] IARC [International Agency for Research on Cancer]. (2013). Diesel and gasoline engine exhausts and some nitroarenes. IARC Monographs Volume 105. [Online at *http://monographs.iarc.fr/ENG/Monographs/vol105/index.php*].

[457] U.S. EPA. (2011) Summary of Results for the 2005 National-Scale Assessment. *www.epa.gov/ttn/atw/nata2005/05pdf/sum_results.pdf*.

[458] U.S. EPA (2011) 2005 National-Scale Air Toxics Assessment. *http://www.epa.gov/ttn/atw/nata2005*.

[459] U.S. EPA. (2000). Integrated Risk Information System File for Benzene. This material is available electronically at: *http://www.epa.gov/iris/subst/0276.htm*.

[460] International Agency for Research on Cancer, IARC monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29, some industrial chemicals and dyestuffs, International Agency for Research on Cancer, World Health Organization, Lyon, France 1982.

[461] Irons, R.D.; Stillman, W.S.; Colagiovanni, D.B.; Henry, V.A. (1992). Synergistic action of the benzene metabolite hydroquinone on myelopoietic stimulating activity of granulocyte/macrophage colony-stimulating factor in vitro, Proc. Natl. Acad. Sci. 89:3691–3695.

[462] A unit risk estimate is defined as the increase in the lifetime risk of an individual who is exposed for a lifetime to 1 μg/m3 benzene in air.

[463] U.S. EPA. (2000). Integrated Risk Information System File for Benzene. This material is available electronically at: *http://www.epa.gov/iris/subst/0276.htm*.

[464] International Agency for Research on Cancer (IARC). (1987). Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29, Supplement 7, Some industrial chemicals and dyestuffs, World Health Organization, Lyon, France.

[465] NTP. (2014). 13th Report on Carcinogens. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program.

[466] Aksoy, M. (1989). Hematotoxicity and carcinogenicity of benzene. Environ. Health Perspect. 82: 193–197.

The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.[468 469] EPA's inhalation reference concentration (RfC) for benzene is 30 μg/m[3]. The RfC is based on suppressed absolute lymphocyte counts seen in humans under occupational exposure conditions. In addition, recent work, including studies sponsored by the Health Effects Institute, provides evidence that biochemical responses are occurring at lower levels of benzene exposure than previously known.[470 471 472 473] EPA's IRIS program has not yet evaluated these new data. EPA does not currently have an acute reference concentration for benzene. The Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Level (MRL) for acute exposure to benzene is 29 μg/m[3] for 1–14 days exposure.[474 475]

(c) 1,3-Butadiene

EPA has characterized 1,3-butadiene as carcinogenic to humans by inhalation.[476 477] The IARC has determined that 1,3-butadiene is a human carcinogen and the U.S. DHHS has characterized 1,3-butadiene as a known human carcinogen.[478 479 480] There are numerous studies consistently demonstrating that 1,3-butadiene is metabolized into genotoxic metabolites by experimental animals and humans. The specific mechanisms of 1,3-butadiene-induced carcinogenesis are unknown; however, the scientific evidence strongly suggests that the carcinogenic effects are mediated by genotoxic metabolites. Animal data suggest that females may be more sensitive than males for cancer effects associated with 1,3-butadiene exposure; there are insufficient data in humans from which to draw conclusions about sensitive subpopulations. The URE for 1,3-butadiene is 3×10^{-5} per μg/m[3].[481] 1,3-butadiene also causes a variety of reproductive and developmental effects in mice; no human data on these effects are available. The most sensitive effect was ovarian atrophy observed in a lifetime bioassay of female mice.[482] Based on this critical effect and the benchmark concentration methodology, an RfC for chronic health effects was calculated at 0.9 ppb (approximately 2 μg/m[3]).

(d) Formaldehyde

In 1991, EPA concluded that formaldehyde is a carcinogen based on nasal tumors in animal bioassays.[483] An Inhalation URE for cancer and a Reference Dose for oral noncancer effects were developed by the agency and posted on the IRIS database. Since that time, the National Toxicology Program (NTP) and International Agency for Research on Cancer (IARC) have concluded that formaldehyde is a known human carcinogen.[484 485]

The conclusions by IARC and NTP reflect the results of epidemiologic research published since 1991 in combination with previous animal, human and mechanistic evidence. Research conducted by the National Cancer Institute reported an increased risk of nasopharyngeal cancer and specific lymph hematopoietic malignancies among workers exposed to formaldehyde.[486 487 488] A National Institute of Occupational Safety and Health study of garment workers also reported increased risk of death due to leukemia among workers exposed to formaldehyde.[489] Extended follow-up of a cohort of British chemical workers did not report evidence of an increase in nasopharyngeal or lymph hematopoietic cancers, but a continuing statistically significant excess in lung cancers was reported.[490] Finally, a study of embalmers reported formaldehyde exposures to be associated with an increased risk of myeloid leukemia but not brain cancer.[491]

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[467] Goldstein, B.D. (1988). Benzene toxicity. Occupational medicine. State of the Art Reviews. 3: 541–554.

[468] Rothman, N., G.L. Li, M. Dosemeci, W.E. Bechtold, G.E. Marti, Y.Z. Wang, M. Linet, L.Q. Xi, W. Lu, M.T. Smith, N. Titenko-Holland, L.P. Zhang, W. Blot, S.N. Yin, and R.B. Hayes. (1996). Hematotoxicity among Chinese workers heavily exposed to benzene. Am. J. Ind. Med. 29: 236–246.

[469] U.S. EPA. (2002). Toxicological Review of Benzene (Noncancer Effects). Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington DC. This material is available electronically at *http://www.epa.gov/iris/subst/0276.htm*.

[470] Qu, O.; Shore, R.; Li, G.; Jin, X.; Chen, C.L.; Cohen, B.; Melikian, A.; Eastmond, D.; Rappaport, S.; Li, H.; Rupa, D.; Suramaya, R.; Songnian, W.; Huifant, Y.; Meng, M.; Winnik, M.; Kwok, E.; Li, Y.; Mu, R.; Xu, B.; Zhang, X.; Li, K. (2003). HEI Report 115, Validation & Evaluation of Biomarkers in Workers Exposed to Benzene in China.

[471] Qu, Q., R. Shore, G. Li, X. Jin, L.C. Chen, B. Cohen, et al. (2002). Hematological changes among Chinese workers with a broad range of benzene exposures. Am. J. Industr. Med. 42: 275–285.

[472] Lan, Qing, Zhang, L., Li, G., Vermeulen, R., et al. (2004). Hematotoxically in Workers Exposed to Low Levels of Benzene. Science 306: 1774–1776.

[473] Turtletaub, K.W. and Mani, C. (2003). Benzene metabolism in rodents at doses relevant to human exposure from Urban Air. Research Reports Health Effect Inst. Report No.113.

[474] U.S. Agency for Toxic Substances and Disease Registry (ATSDR). (2007). Toxicological profile for benzene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. *http://www.atsdr.cdc.gov/ToxProfiles/tp3.pdf*.

[475] A minimal risk level (MRL) is defined as an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure.

[476] U.S. EPA. (2002). Health Assessment of 1,3-Butadiene. Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC. Report No. EPA600–P–98–001F. This document is available electronically at *http://www.epa.gov/iris/supdocs/buta-sup.pdf*.

[477] U.S. EPA. (2002). ''Full IRIS Summary for 1,3-butadiene (CASRN 106–99–0)'' Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington, DC *http://www.epa.gov/iris/subst/0139.htm*.

[478] International Agency for Research on Cancer (IARC). (1999). Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 71, Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide and Volume 97 (in preparation), World Health Organization, Lyon, France.

[479] International Agency for Research on Cancer (IARC). (2008). Monographs on the evaluation of carcinogenic risk of chemicals to humans, 1,3-Butadiene, Ethylene Oxide and Vinyl Halides (Vinyl Fluoride, Vinyl Chloride and Vinyl Bromide) Volume 97, World Health Organization, Lyon, France.

[480] NTP. (2014). 13th Report on Carcinogens. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program.

[481] U.S. EPA. (2002). ''Full IRIS Summary for 1,3-butadiene (CASRN 106–99–0)'' Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington, DC *http://www.epa.gov/iris/subst/0139.htm*.

[482] Bevan, C.; Stadler, J.C.; Elliot, G.S.; et al. (1996). Subchronic toxicity of 4-vinylcyclohexene in rats and mice by inhalation. Fundam. Appl. Toxicol. 32:1–10.

[483] EPA. Integrated Risk Information System. Formaldehyde (CASRN 50–00–0) *http://www.epa.gov/iris/subst/0419/htm*.

[484] NTP. (2014). 13th Report on Carcinogens. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program.

[485] IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 100F (2012): Formaldehyde.

[486] Hauptmann, M.; Lubin, J.H.; Stewart, P.A.; Hayes, R.B.; Blair, A. 2003. Mortality from lymphohematopoetic malignancies among workers in formaldehyde industries. Journal of the National Cancer Institute 95: 1615–1623.

[487] Hauptmann, M.; Lubin, J.H.; Stewart, P.A.; Hayes, R.B.; Blair, A. 2004. Mortality from solid cancers among workers in formaldehyde industries. American Journal of Epidemiology 159: 1117–1130.

[488] Beane Freeman, L.E.; Blair, A.; Lubin, J.H.; Stewart, P.A.; Hayes, R.B.; Hoover, R.N.; Hauptmann, M. 2009. Mortality from lymph hematopoietic malignancies among workers in formaldehyde industries: The National Cancer Institute cohort. J. National Cancer Inst. 101: 751–761.

[489] Pinkerton, L.E. 2004. Mortality among a cohort of garment workers exposed to formaldehyde: An update. Occup. Environ. Med. 61: 193–200.

[490] Coggon, D., E.C. Harris, J. Poole, K.T. Palmer. 2003. Extended follow-up of a cohort of British chemical workers exposed to formaldehyde. J National Cancer Inst. 95:1608–1615.

[491] Hauptmann, M,; Stewart P.A.; Lubin J.H.; Beane Freeman, L.E.; Hornung, R.W.; Herrick, R.F.; Hoover, R.N.; Fraumeni, J.F.; Hayes, R.B. 2009. Mortality from lymph hematopoietic malignancies

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Health effects of formaldehyde in addition to cancer were reviewed by the Agency for Toxics Substances and Disease Registry in 1999 [492] and supplemented in 2010,[493] and by the World Health Organization.[494] These organizations reviewed the scientific literature concerning health effects linked to formaldehyde exposure to evaluate hazards and dose response relationships and defined exposure concentrations for minimal risk levels (MRLs). The health endpoints reviewed included sensory irritation of eyes and respiratory tract, pulmonary function, nasal histopathology, and immune system effects. In addition, research on reproductive and developmental effects and neurological effects were discussed along with several studies that suggest that formaldehyde may increase the risk of asthma—particularly in the young.

EPA released a draft Toxicological Review of Formaldehyde—Inhalation Assessment through the IRIS program for peer review by the National Research Council (NRC) and public comment in June 2010.[495] The draft assessment reviewed more recent research from animal and human studies on cancer and other health effects. The NRC released their review report in April 2011.[496] EPA is currently developing a new draft assessment in response to this review.

(e) Acetaldehyde

Acetaldehyde is classified in EPA's IRIS database as a probable human carcinogen, based on nasal tumors in rats, and is considered toxic by the inhalation, oral, and intravenous routes.[497] The URE in IRIS for acetaldehyde is 2.2×10^{-6} per μg/m^3.[498] Acetaldehyde is reasonably anticipated to be a human carcinogen by the U.S. DHHS in the 13th Report on Carcinogens and is classified as possibly carcinogenic to humans (Group 2B) by the IARC.[499] [500] EPA is currently conducting a reassessment of cancer risk from inhalation exposure to acetaldehyde.

The primary noncancer effects of exposure to acetaldehyde vapors include irritation of the eyes, skin, and respiratory tract.[501] In short-term (4 week) rat studies, degeneration of olfactory epithelium was observed at various concentration levels of acetaldehyde exposure.[502] [503] Data from these studies were used by EPA to develop an inhalation reference concentration of 9 μg/m^3. Some asthmatics have been shown to be a sensitive subpopulation to decrements in functional expiratory volume (FEV1 test) and bronchoconstriction upon acetaldehyde inhalation.[504] The agency is currently conducting a reassessment of the health hazards from inhalation exposure to acetaldehyde.

(f) Acrolein

EPA most recently evaluated the toxicological and health effects literature related to acrolein in 2003 and concluded that the human carcinogenic potential of acrolein could not be determined because the available data were inadequate. No information was available on the carcinogenic effects of acrolein in humans and the animal data provided inadequate evidence of carcinogenicity.[505] The IARC determined in 1995 that acrolein was not classifiable as to its carcinogenicity in humans.[506]

Lesions to the lungs and upper respiratory tract of rats, rabbits, and hamsters have been observed after subchronic exposure to acrolein.[507] The agency has developed an RfC for acrolein of 0.02 μg/m^3 and an RfD of 0.5 μg/kg-day.[508] EPA is considering updating the acrolein assessment with data that have become available since the 2003 assessment was completed.

Acrolein is extremely acrid and irritating to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation, mucus hypersecretion and congestion. The intense irritancy of this carbonyl has been demonstrated during controlled tests in human subjects, who suffer intolerable eye and nasal mucosal sensory reactions within minutes of exposure.[509] These data and additional studies regarding acute effects of human exposure to acrolein are summarized in EPA's 2003 IRIS Human Health Assessment for acrolein.[510] Studies in humans indicate that levels as low as 0.09 ppm (0.21 mg/m^3) for five minutes may elicit subjective complaints of eye irritation with increasing concentrations leading to more extensive eye, nose and respiratory symptoms. Acute exposures in animal studies report bronchial

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and brain cancer among embalmers exposed to formaldehyde. Journal of the National Cancer Institute 101:1696–1708.

[492] ATSDR. 1999. Toxicological Profile for Formaldehyde, U.S. Department of Health and Human Services (HHS), July 1999.

[493] ATSDR. 2010. Addendum to the Toxicological Profile for Formaldehyde. U.S. Department of Health and Human Services (HHS), October 2010.

[494] IPCS. 2002. Concise International Chemical Assessment Document 40. Formaldehyde. World Health Organization.

[495] EPA (U.S. Environmental Protection Agency). 2010. Toxicological Review of Formaldehyde (CAS No. 50–00–0)—Inhalation Assessment: In Support of Summary Information on the Integrated Risk Information System (IRIS). External Review Draft. EPA/635/R–10/002A. U.S. Environmental Protection Agency, Washington, DC [online]. Available: *http://cfpub.epa.gov/ncea/irs_drats/recordisplay.cfm?deid=223614.*

[496] NRC (National Research Council). 2011. Review of the Environmental Protection Agency's Draft IRIS Assessment of Formaldehyde. Washington DC: National Academies Press. *http://books.nap.edu/openbook.php?record_id=13142.*

[497] U.S. EPA (1991). Integrated Risk Information System File of Acetaldehyde. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0290.htm.*

[498] U.S. EPA (1991). Integrated Risk Information System File of Acetaldehyde. This material is available electronically at *http://www.epa.gov/iris/subst/0290.htm.*

[499] NTP. (2014). 13th Report on Carcinogens. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program.

[500] International Agency for Research on Cancer (IARC). (1999). Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemical to Humans, Vol 71. Lyon, France.

[501] U.S. EPA (1991). Integrated Risk Information System File of Acetaldehyde. This material is available electronically at *http://www.epa.gov/iris/subst/0290.htm.*

[502] U.S. EPA. (2003). Integrated Risk Information System File of Acrolein. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0364.htm.*

[503] Appleman, L.M., R.A. Woutersen, and V.J. Feron. (1982). Inhalation toxicity of acetaldehyde in rats. I. Acute and subacute studies. Toxicology. 23: 293–297.

[504] Myou, S.; Fujimura, M.; Nishi K.; Ohka, T.; and Matsuda, T. (1993) Aerosolized acetaldehyde induces histamine-mediated bronchoconstriction in asthmatics. Am. Rev. Respir. Dis. 148(4 Pt 1): 940–943.

[505] U.S. EPA. (2003). Integrated Risk Information System File of Acrolein. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available at *http://www.epa.gov/iris/subst/0364.htm.*

[506] International Agency for Research on Cancer (IARC). (1995). Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 63. Dry cleaning, some chlorinated solvents and other industrial chemicals, World Health Organization, Lyon, France.

[507] U.S. EPA. (2003). Integrated Risk Information System File of Acrolein. Office of Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available at *http://www.epa.gov/iris/subst/0364.htm.*

[508] U.S. EPA. (2003). Integrated Risk Information System File of Acrolein. Office of Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available at *http://www.epa.gov/iris/subst/0364.htm.*

[509] U.S. EPA. (2003) Toxicological review of acrolein in support of summary information on Integrated Risk Information System (IRIS) National Center for Environmental Assessment, Washington, DC. EPA/635/R–03/003. p. 10. Available online at: *http://www.epa.gov/ncea/iris/toxreviews/0364tr.pdf.*

[510] U.S. EPA. (2003) Toxicological review of acrolein in support of summary information on Integrated Risk Information System (IRIS) National Center for Environmental Assessment, Washington, DC. EPA/635/R–03/003. Available online at: *http://www.epa.gov/ncea/iris/toxreviews/0364tr.pdf.*

hyper-responsiveness. Based on animal data (more pronounced respiratory irritancy in mice with allergic airway disease in comparison to non-diseased mice [511]) and demonstration of similar effects in humans (*e.g.,* reduction in respiratory rate), individuals with compromised respiratory function (*e.g.,* emphysema, asthma) are expected to be at increased risk of developing adverse responses to strong respiratory irritants such as acrolein. EPA does not currently have an acute reference concentration for acrolein. The available health effect reference values for acrolein have been summarized by EPA and include an ATSDR MRL for acute exposure to acrolein of 7 $\mu g/m^3$ for 1–14 days exposure; and Reference Exposure Level (REL) values from the California Office of Environmental Health Hazard Assessment (OEHHA) for one-hour and 8-hour exposures of 2.5 $\mu g/m^3$ and 0.7 $\mu g/m^3$, respectively.[512]

(g) Polycyclic Organic Matter

The term polycyclic organic matter (POM) defines a broad class of compounds that includes the polycyclic aromatic hydrocarbon compounds (PAHs). One of these compounds, naphthalene, is discussed separately below. POM compounds are formed primarily from combustion and are present in the atmosphere in gas and particulate form. Cancer is the major concern from exposure to POM. Epidemiologic studies have reported an increase in lung cancer in humans exposed to diesel exhaust, coke oven emissions, roofing tar emissions, and cigarette smoke; all of these mixtures contain POM compounds.[513] [514] Animal studies have reported respiratory tract tumors from inhalation exposure to benzo[a]pyrene and alimentary tract and liver tumors from oral exposure to benzo[a]pyrene.[515] In 1997 EPA classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens.[516] Since that time, studies have found that maternal exposures to PAHs in a population of pregnant women were associated with several adverse birth outcomes, including low birth weight and reduced length at birth, as well as impaired cognitive development in preschool children (3 years of age).[517] [518] These and similar studies are being evaluated as a part of the ongoing IRIS assessment of health effects associated with exposure to benzo[a]pyrene.

(h) Naphthalene

Naphthalene is found in small quantities in gasoline and diesel fuels. Naphthalene emissions have been measured in larger quantities in both gasoline and diesel exhaust compared with evaporative emissions from mobile sources, indicating it is primarily a product of combustion. Acute (short-term) exposure of humans to naphthalene by inhalation, ingestion, or dermal contact is associated with hemolytic anemia and damage to the liver and the nervous system.[519] Chronic (long term) exposure of workers and rodents to naphthalene has been reported to cause cataracts and retinal damage.[520] EPA released an external review draft of a reassessment of the inhalation carcinogenicity of naphthalene based on a number of recent animal carcinogenicity studies.[521] The draft reassessment completed external peer review.[522] Based on external peer review comments received, a revised draft assessment that considers all routes of exposure, as well as cancer and noncancer effects, is under development. The external review draft does not represent official agency opinion and was released solely for the purposes of external peer review and public comment. The National Toxicology Program listed naphthalene as ''reasonably anticipated to be a human carcinogen'' in 2004 on the basis of bioassays reporting clear evidence of carcinogenicity in rats and some evidence of carcinogenicity in mice.[523] California EPA has released a new risk assessment for naphthalene, and the IARC has reevaluated naphthalene and re-classified it as Group 2B: Possibly carcinogenic to humans.[524]

Naphthalene also causes a number of chronic non-cancer effects in animals, including abnormal cell changes and growth in respiratory and nasal tissues.[525] The current EPA IRIS assessment includes noncancer data on hyperplasia and metaplasia in nasal tissue that form the basis of the inhalation RfC of 3 $\mu g/m^3$.[526] The

[511] Morris J.B., Symanowicz P.T., Olsen J.E., et al. (2003). Immediate sensory nerve-mediated respiratory responses to irritants in healthy and allergic airway-diseased mice. J Appl Physiol 94(4):1563–1571.

[512] U.S. EPA. (2009). Graphical Arrays of Chemical-Specific Health Effect Reference Values for Inhalation Exposures (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–09/061, 2009. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=211003.*

[513] Agency for Toxic Substances and Disease Registry (ATSDR). (1995). Toxicological profile for Polycyclic Aromatic Hydrocarbons (PAHs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available electronically at *http://www.atsdr.cdc.gov/ToxProfiles/TP.asp?id=122&tid=25.*

[514] U.S. EPA (2002). *Health Assessment Document for Diesel Engine Exhaust.* EPA/600/8–90/057F Office of Research and Development, Washington, DC. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060.*

[515] International Agency for Research on Cancer (IARC). (2012). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans, Chemical Agents and Related Occupations. Vol. 100F. Lyon, France.

[516] U.S. EPA (1997). Integrated Risk Information System File of indeno (1,2,3-cd) pyrene. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/ncea/iris/subst/0457.htm.*

[517] Perera, F.P.; Rauh, V.; Tsai, W–Y.; et al. (2002). Effect of transplacental exposure to environmental pollutants on birth outcomes in a multiethnic population. Environ Health Perspect. 111: 201–205.

[518] Perera, F.P.; Rauh, V.; Whyatt, R.M.; Tsai, W.Y.; Tang, D.; Diaz, D.; Hoepner, L.; Barr, D.; Tu, Y.H.; Camann, D.; Kinney, P. (2006). Effect of prenatal exposure to airborne polycyclic aromatic hydrocarbons on neurodevelopment in the first 3 years of life among inner-city children. Environ Health Perspect 114: 1287–1292.

[519] U.S. EPA. 1998. Toxicological Review of Naphthalene (Reassessment of the Inhalation Cancer Risk), Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0436.htm.*

[520] U.S. EPA. 1998. Toxicological Review of Naphthalene (Reassessment of the Inhalation Cancer Risk), Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0436.htm.*

[521] U.S. EPA. (1998). Toxicological Review of Naphthalene (Reassessment of the Inhalation Cancer Risk), Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0436.htm.*

[522] Oak Ridge Institute for Science and Education. (2004). External Peer Review for the IRIS Reassessment of the Inhalation Carcinogenicity of Naphthalene. August 2004. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=84403.*

[523] NTP. (2014). 13th Report on Carcinogens. U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program.

[524] International Agency for Research on Cancer (IARC). (2002). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans. Vol. 82. Lyon, France.

[525] U.S. EPA. (1998). Toxicological Review of Naphthalene, Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0436.htm.*

[526] U.S. EPA. (1998). Toxicological Review of Naphthalene. Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington, DC *http://www.epa.gov/iris/subst/0436.htm.*

ATSDR MRL for acute exposure to naphthalene is 0.6 mg/kg/day.

(i) Other Air Toxics

In addition to the compounds described above, other compounds in gaseous hydrocarbon and PM emissions from motor vehicles will be affected by this action. Mobile source air toxic compounds that will potentially be impacted include ethylbenzene, propionaldehyde, toluene, and xylene. Information regarding the health effects of these compounds can be found in EPA's IRIS database.[527]

(8) Exposure and Health Effects Associated With Traffic

Locations in close proximity to major roadways generally have elevated concentrations of many air pollutants emitted from motor vehicles. Hundreds of such studies have been published in peer-reviewed journals, concluding that concentrations of CO, NO, NO_2, benzene, aldehydes, particulate matter, black carbon, and many other compounds are elevated in ambient air within approximately 300–600 meters (about 1,000–2,000 feet) of major roadways. Highest concentrations of most pollutants emitted directly by motor vehicles are found at locations within 50 meters (about 165 feet) of the edge of a roadway's traffic lanes.

A recent large-scale review of air quality measurements in vicinity of major roadways between 1978 and 2008 concluded that the pollutants with the steepest concentration gradients in vicinities of roadways were CO, ultrafine particles, metals, elemental carbon (EC), NO, NO_X, and several VOCs.[528] These pollutants showed a large reduction in concentrations within 100 meters downwind of the roadway. Pollutants that showed more gradual reductions with distance from roadways included benzene, NO_2, $PM_{2.5}$, and PM_{10}. In the review article, results varied based on the method of statistical analysis used to determine the trend.

For pollutants with relatively high background concentrations relative to near-road concentrations, detecting concentration gradients can be difficult. For example, many aldehydes have high background concentrations as a result of photochemical breakdown of precursors from many different organic compounds. This can make detection of gradients around roadways and other primary emission sources difficult. However, several studies have measured aldehydes in multiple weather conditions, and found higher concentrations of many carbonyls downwind of roadways.[529] [530] These findings suggest a substantial roadway source of these carbonyls.

In the past 15 years, many studies have been published with results reporting that populations who live, work, or go to school near high-traffic roadways experience higher rates of numerous adverse health effects, compared to populations far away from major roads.[531] In addition, numerous studies have found adverse health effects associated with spending time in traffic, such as commuting or walking along high-traffic roadways.[532] [533] [534] [535] The health outcomes with the strongest evidence linking them with traffic-associated air pollutants are respiratory effects, particularly in asthmatic children, and cardiovascular effects.

Numerous reviews of this body of health literature have been published as well. In 2010, an expert panel of the Health Effects Institute (HEI) published a review of hundreds of exposure, epidemiology, and toxicology studies.[536] The panel rated how the evidence for each type of health outcome supported a conclusion of a causal association with traffic-associated air pollution as either ''sufficient,'' ''suggestive but not sufficient,'' or ''inadequate and insufficient.'' The panel categorized evidence of a causal association for exacerbation of childhood asthma as ''sufficient.'' The panel categorized evidence of a causal association for new onset asthma as between ''sufficient'' and as ''suggestive but not sufficient.'' ''Suggestive of a causal association'' was how the panel categorized evidence linking traffic-associated air pollutants with exacerbation of adult respiratory symptoms and lung function decrement. It categorized as ''inadequate and insufficient'' evidence of a causal relationship between traffic-related air pollution and health care utilization for respiratory problems, new onset adult asthma, chronic obstructive pulmonary disease (COPD), nonasthmatic respiratory allergy, and cancer in adults and children. Other literature reviews have been published with conclusions generally similar to the HEI panel's.[537] [538] [539] [540] However, researchers from the U.S. Centers for Disease Control and Prevention (CDC) recently published a systematic review and meta-analysis of studies evaluating the risk of childhood leukemia associated with traffic exposure, and reported positive associations between ''postnatal'' proximity to traffic and leukemia risks, but no such association for ''prenatal'' exposures.[541]

Health outcomes with few publications suggest the possibility of other effects still lacking sufficient evidence to draw definitive conclusions. Among these outcomes with a small number of positive studies are neurological impacts (*e.g.,* autism and reduced cognitive function) and reproductive outcomes (*e.g.,* preterm birth, low birth weight).[542] [543] [544] [545]

[527] U.S. EPA Integrated Risk Information System (IRIS) database is available at: *www.epa.gov/iris.*

[528] Karner, A.A.; Eisinger, D.S.; Niemeier, D.A. (2010). Near-roadway air quality: Synthesizing the findings from real-world data. Environ Sci Technol 44: 5334–5344.

[529] Liu, W.; Zhang, J.; Kwon, J.l; et l. (2006). Concentrations and source characteristics of airborne carbonyl comlbs measured outside urban residences. J Air Waste Manage Assoc 56: 1196–1204.

[530] Cahill, T.M.; Charles, M.J.; Seaman, V.Y. (2010). Development and application of a sensitive method to determine concentrations of acrolein and other carbonyls in ambient air. Health Effects Institute Research Report 149.Available at *http://dx.doi.org.*

[531] In the widely-used PubMed database of health publications, between January 1, 1990 and August 18, 2011, 605 publications contained the keywords ''traffic, pollution, epidemiology,'' with approximately half the studies published after 2007.

[532] Laden, F.; Hart, J.E.; Smith, T.J.; Davis, M.E.; Garshick, E. (2007) Cause-specific mortality in the unionized U.S. trucking industry. Environmental Health Perspect 115:1192–1196.

[533] Peters, A.; von Klot, S.; Heier, M.; Trentinaglia, I.; Hörmann, A.; Wichmann, H.E.; Löwel, H. (2004) Exposure to traffic and the onset of myocardial infarction. New England J Med 351: 1721–1730.

[534] Zanobetti, A.; Stone, P.H.; Spelzer, F.E.; Schwartz, J.D.; Coull, B.A.; Suh, H.H.; Nearling, B.D.; Mittleman, M.A.; Verrier, R.L.; Gold, D.R. (2009) T-wave alternans, air pollution and traffic in high-risk subjects. Am J Cardiol 104: 665–670.

[535] Dubowsky Adar, S.; Adamkiewicz, G.; Gold, D.R.; Schwartz, J.; Coull, B.A.; Suh, H. (2007) Ambient and microenvironmental particles and exhaled nitric oxide before and after a group bus trip. Environ Health Perspect 115: 507–512.

[536] Health Effects Institute Panel on the Health Effects of Traffic-Related Air Pollution. (2010). Traffic-related air pollution: A critical review of the literature on emissions, exposure, and health effects. HEI Special Report 17. Available at *http://www.healtheffects.org.*

[537] Boothe, V.L.; Shendell, D.G. (2008). Potential health effects associated with residential proximity to freeways and primary roads: Review of scientific literature, 1999–2006. J Environ Health 70: 33–41.

[538] Salam, M.T.; Islam, T.; Gilliland, F.D. (2008). Recent evidence for adverse effects of residential proximity to traffic sources on asthma. Curr Opin Pulm Med 14: 3–8.

[539] Sun, X.; Zhang, S.; Ma, X. (2014) No association between traffic density and risk of childhood leukemia: A meta-analysis. Asia Pac J Cancer Prev 15: 5229–5232.

[540] Raaschou-Nielsen, O.; Reynolds, P. (2006). Air pollution and childhood cancer: A review of the epidemiological literature. Int J Cancer 118: 2920–9.

[541] Boothe, V.L.; Boehmer, T.K.; Wendel, A.M.; Yip, F.Y. (2014) Residential traffic exposure and childhood leukemia: A systematic review and meta-analysis. Am J Prev Med 46: 413–422.

[542] Volk, H.E.; Hertz-Picciotto, I.; Delwiche, L.; et al. (2011). Residential proximity to freeways and autism in the CHARGE study. Environ Health Perspect 119: 873–877.

In addition to health outcomes, particularly cardiopulmonary effects, conclusions of numerous studies suggest mechanisms by which traffic-related air pollution affects health. Numerous studies indicate that near-roadway exposures may increase systemic inflammation, affecting organ systems, including blood vessels and lungs.[546 547 548 549] Long-term exposures in near-road environments have been associated with inflammation-associated conditions, such as atherosclerosis and asthma.[550 551 552]

Several studies suggest that some factors may increase susceptibility to the effects of traffic-associated air pollution. Several studies have found stronger respiratory associations in children experiencing chronic social stress, such as in violent neighborhoods or in homes with high family stress.[553 554 555]

The risks associated with residence, workplace, or schools near major roads are of potentially high public health significance due to the large population in such locations. According to the 2009 American Housing Survey, over 22 million homes (17.0 percent of all U.S. housing units) were located within 300 feet of an airport, railroad, or highway with four or more lanes. This corresponds to a population of more than 50 million U.S. residents in close proximity to high-traffic roadways or other transportation sources. Based on 2010 Census data, a 2013 publication estimated that 19 percent of the U.S. population (over 59 million people) lived within 500 meters of roads with at least 25,000 annual average daily traffic (AADT), while about 3.2 percent of the population lived within 100 meters (about 300 feet) of such roads.[556] Another 2013 study estimated that 3.7 percent of the U.S. population (about 11.3 million people) lived within 150 meters (about 500 feet) of interstate highways, or other freeways and expressways.[557] As discussed in Section VIII. B. (9), on average, populations near major roads have higher fractions of minority residents and lower socioeconomic status. Furthermore, on average, Americans spend more than an hour traveling each day, bringing nearly all residents into a high-exposure microenvironment for part of the day.

In light of these concerns, EPA has required and is working with states to ensure that air quality monitors be placed near high-traffic roadways for determining NAAQS compliance for CO, NO_2, and $PM_{2.5}$ (in addition to those existing monitors located in neighborhoods and other locations farther away from pollution sources). Near-roadway monitors for NO_2 begin operation between 2014 and 2017 in Core Based Statistical Areas (CBSAs) with population of at least 500,000. Monitors for CO and $PM_{2.5}$ begin operation between 2015 and 2017. These monitors will further our understanding of exposure in these locations.

EPA and DOT continue to research near-road air quality, including the types of pollutants found in high concentrations near major roads and health problems associated with the mixture of pollutants near roads.

(9) Environmental Justice

Environmental justice (EJ) is a principle asserting that all people deserve fair treatment and meaningful involvement with respect to environmental laws, regulations, and policies. EPA seeks to provide the same degree of protection from environmental health hazards for all people. DOT shares this goal and is informed about the potential environmental impacts of its rulemakings through its NEPA process (see NHTSA's DEIS). As referenced below, numerous studies have found that some environmental hazards are more prevalent in areas where racial/ethnic minorities and people with low socioeconomic status (SES), represent a higher fraction of the population compared with the general population.

As discussed in Section VIII. B. (8) of this document and NHTSA's DEIS, concentrations of many air pollutants are elevated near high-traffic roadways. If minority populations and low-income populations disproportionately live near such roads, then an issue of EJ may be present. We reviewed existing scholarly literature examining the potential for disproportionate exposure among minorities and people with low SES and we conducted our own evaluation of two national datasets: The U.S. Census Bureau's American Housing Survey for calendar year 2009 and the U.S. Department of Education's database of school locations.

Publications that address EJ issues generally report that populations living near major roadways (and other types of transportation infrastructure) tend to be composed of larger fractions of nonwhite residents. People living in neighborhoods near such sources of air pollution also tend to be lower in income than people living elsewhere. Numerous studies evaluating the demographics and socioeconomic status of populations or schools near roadways have found that they include a greater percentage of minority residents, as well as lower SES (indicated by variables such as median household income). Locations in these studies include Los Angeles, CA; Seattle, WA; Wayne County, MI; Orange County, FL; and the

543 Franco-Suglia, S.; Gryparis, A.; Wright, R.O.; et al. (2007). Association of black carbon with cognition among children in a prospective birth cohort study. Am J Epidemiol. doi: 10.1093/aje/kwm308. [Online at *http://dx.doi.org*].

544 Power, M.C.; Weisskopf, M.G.; Alexeef, S.E.; et al. (2011). Traffic-related air pollution and cognitive function in a cohort of older men. Environ Health Perspect 2011: 682–687.

545 Wu, J.; Wilhelm, M.; Chung, J.; et al. (2011). Comparing exposure assessment methods for traffic-related air pollution in an adverse pregnancy outcome study. Environ Res 111: 685–6692.

546 Riediker, M. (2007). Cardiovascular effects of fine particulate matter components in highway patrol officers. Inhal Toxicol 19: 99–105. doi: 10.1080/08958370701495238. Available at *http://dx.doi.org.*

547 Alexeef, S.E.; Coull, B.A.; Gryparis, A.; et al. (2011). Medium-term exposure to traffic-related air pollution and markers of inflammation and endothelial function. Environ Health Perspect 119: 481–486. doi:10.1289/ehp.1002560. Available at *http://dx.doi.org.*

548 Eckel. S.P.; Berhane, K.; Salam, M.T.; et al. (2011). Traffic-related pollution exposure and exhaled nitric oxide in the Children's Health Study. Environ Health Perspect (IN PRESS). doi:10.1289/ehp.1103516. Available at *http://dx.doi.org.*

549 Zhang, J.; McCreanor, J.E.; Cullinan, P.; et al. (2009). Health effects of real-world exposure diesel exhaust in persons with asthma. Res Rep Health Effects Inst 138. [Online at *http://www.healtheffects.org*].

550 Adar, S.D.; Klein, R.; Klein, E.K.; et al. (2010). Air pollution and the microvasculatory: A cross-sectional assessment of in vivo retinal images in the population-based Multi-Ethnic Study of Atherosclerosis. PLoS Med 7(11): E1000372. doi:10.1371/journal.pmed.1000372. Available at *http://dx.doi.org.*

551 Kan, H.; Heiss, G.; Rose, K.M.; et al. (2008). Proxpective analysis of traffic exposure as a risk factor for incident coronary heart disease: The Atherosclerosis Risk in Communities (ARIC) study. Environ Health Perspect 116: 1463–1468. doi:10.1289/ehp.11290. Available at *http://dx.doi.org.*

552 McConnell, R.; Islam, T.; Shankardass, K.; et al. (2010). Childhood incident asthma and traffic-related air pollution at home and school. Environ Health Perspect 1021–1026.

553 Islam, T.; Urban, R.; Gauderman, W.J.; et al. (2011). Parental stress increases the detrimental effect of traffic exposure on children's lung function. Am J Respir Crit Care Med (In press).

554 Clougherty, J.E.; Levy, J.I.; Kubzansky, L.D.; et al. (2007). Synergistic effects of traffic-related air pollution and exposure to violence on urban asthma etiology. Environ Health Perspect 115: 1140–1146.

555 Chen, E.; Schrier, H.M.; Strunk, R.C.; et al. (2008). Chronic traffic-related air pollution and stress interact to predict biologic and clinical outcomes in asthma. Environ Health Perspect 116: 970–5.

556 Rowangould, G.M. (2013) A census of the U.S. near-roadway population: Public health and environmental justice considerations. Transportation Research Part D 25: 59–67.

557 Boehmer, T.K.; Foster, S.L.; Henry, J.R.; Woghiren-Akinnifesi, E.L.; Yip, F.Y. (2013) Residential proximity to major highways—United States, 2010. Morbidity and Mortality Weekly Report 62(3); 46–50.

State of California[558] [559] [560] [561] [562] [563] Such disparities may be due to multiple factors.[564]

People with low SES often live in neighborhoods with multiple stressors and health risk factors, including reduced health insurance coverage rates, higher smoking and drug use rates, limited access to fresh food, visible neighborhood violence, and elevated rates of obesity and some diseases such as asthma, diabetes, and ischemic heart disease. Although questions remain, several studies find stronger associations between air pollution and health in locations with such chronic neighborhood stress, suggesting that populations in these areas may be more susceptible to the effects of air pollution.[565] [566] [567] [568] Household-level stressors such as parental smoking and relationship stress also may increase susceptibility to the adverse effects of air pollution.[569] [570]

More recently, three publications report nationwide analyses that compare the demographic patterns of people who do or do not live near major roadways.[571] [572] [573] All three of these studies found that people living near major roadways are more likely to be minorities or low in SES. They also found that the outcomes of their analyses varied between regions within the U.S. However, only one such study looked at whether such conclusions were confounded by living in a location with higher population density and how demographics differ between locations nationwide. In general, it found that higher density areas have higher proportions of low income and minority residents.

We analyzed two national databases that allowed us to evaluate whether homes and schools were located near a major road and whether disparities in exposure may be occurring in these environments. The American Housing Survey (AHS) includes descriptive statistics of over 70,000 housing units across the nation. The study survey is conducted every two years by the U.S. Census Bureau. The second database we analyzed was the U.S. Department of Education's Common Core of Data, which includes enrollment and location information for schools across the U.S.

In analyzing the 2009 AHS, we focused on whether or not a housing unit was located within 300 feet of ''4-or-more lane highway, railroad, or airport.'' [574] We analyzed whether there were differences between households in such locations compared with those in locations farther from these transportation facilities.[575] We included other variables, such as land use category, region of country, and housing type. We found that homes with a nonwhite householder were 22–34 percent more likely to be located within 300 feet of these large transportation facilities than homes with white householders. Homes with a Hispanic householder were 17–33 percent more likely to be located within 300 feet of these large transportation facilities than homes with non-Hispanic householders. Households near large transportation facilities were, on average, lower in income and educational attainment, more likely to be a rental property and located in an urban area compared with households more distant from transportation facilities.

In examining schools near major roadways, we examined the Common Core of Data (CCD) from the U.S. Department of Education, which includes information on all public elementary and secondary schools and school districts nationwide.[576] To determine school proximities to major roadways, we used a geographic information system (GIS) to map each school and roadways based on the U.S. Census's TIGER roadway file.[577] We found that minority students were overrepresented at schools within 200 meters of the largest roadways, and that schools within 200 meters of the largest roadways also had higher than expected numbers of students eligible for free or reduced-price lunches. For example, Black students represent 22 percent of students at schools located within 200 meters of a primary road, whereas Black students represent 17 percent of students in all U.S. schools. Hispanic students represent 30 percent of students at schools located within 200 meters of a primary road, whereas Hispanic students represent 22 percent of students in all U.S. schools.

Overall, there is substantial evidence that people who live or attend school near major roadways are more likely to be of a minority race, Hispanic

[558] Marshall, J.D. (2008) Environmental inequality: Air pollution exposures in California's South Coast Air Basin.

[559] Su, J.G.; Larson, T.; Gould, T.; Cohen, M.; Buzzelli, M. (2010) Transboundary air pollution and environmental justice: Vancouver and Seattle compared. GeoJournal 57: 595–608. doi:10.1007/s10708–009–9269–6 [Online at *http://dx.doi.org*].

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[562] Wu, Y.; Batterman, S.A. (2006) Proximity of schools in Detroit, Michigan to automobile and truck traffic. J Exposure Sci & Environ Epidemiol. doi:10.1038/sj.jes.7500484 [Online at *http://dx.doi.org*].

[563] Su, J.G.; Jerrett, M.; de Nazelle, A.; Wolch, J. (2011) Does exposure to air pollution in urban parks have socioeconomic, racial, or ethnic gradients? Environ Res 111: 319–328.

[564] Depro, B.; Timmins, C. (2008) Mobility and environmental equity: Do housing choices determine exposure to air pollution? North Caroline State University Center for Environmental and Resource Economic Policy.

[565] Clougherty, J.E.; Kubzansky, L.D. (2009) A framework for examining social stress and susceptibility to air pollution in respiratory health. Environ Health Perspect 117: 1351–1358. Doi:10.1289/ehp.0900612 [Online at *http://dx.doi.org*].

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[567] Finkelstein, M.M.; Jerrett, M.; DeLuca, P.; Finkelstein, N.; Verma, D.K.; Chapman, K.; Sears, M.R. (2003) Relation between income, air pollution and mortality: a cohort study. Canadian Med Assn J 169: 397–402.

[568] Shankardass, K.; McConnell, R.; Jerrett, M.; Milam, J.; Richardson, J.; Berhane, K. (2009) Parental stress increases the effect of traffic-related air pollution on childhood asthma incidence. Proc Natl Acad Sci 106: 12406–12411. doi:10.1073/pnas.0812910106 [Online at *http://dx.doi.org*].

[569] Lewis, A.S.; Sax, S.N.; Wason, S.C.; Campleman, S.L (2011) Non-chemical stressors and cumulative risk assessment: an overview of current initiatives and potential air pollutant interactions. Int J Environ Res Public Health 8: 2020–2073. Doi:10.3390/ijerph8062020 [Online at *http://dx.doi.org*].

[570] Rosa, M.J.; Jung, K.H.; Perzanowski, M.S.; Kelvin, E.A.; Darling, K.W.; Camann, D.E.; Chillrud, S.N.; Whyatt, R.M.; Kinney, P.L.; Perera, F.P.; Miller, R.L (2010) Prenatal exposure to polycyclic aromatic hydrocarbons, environmental tobacco smoke and asthma. Respir Med (In press). doi:10.1016/j.rmed.2010.11.022 [Online at *http://dx.doi.org*].

[571] Rowangould, G.M. (2013) A census of the U.S. near-roadway population: public health and environmental justice considerations. Transportation Research Part D; 59–67.

[572] Tian, N.; Xue, J.; Barzyk. T.M. (2013) Evaluating socioeconomic and racial differences in traffic-related metrics in the United States using a GIS approach. J Exposure Sci Environ Epidemiol 23: 215–222.

[573] Boehmer, T.K.; Foster, S.L.; Henry, J.R.; Woghiren-Akinnifesi, E.L.; Yip, F.Y. (2013) Residential proximity to major highways—United States, 2010. Morbidity and Mortality Weekly Report 62(3): 46–50.

[574] This variable primarily represents roadway proximity. According to the Central Intelligence Agency's World Factbook, in 2010, the United States had 6,506,204 km or roadways, 224,792 km of railways, and 15,079 airports. Highways thus represent the overwhelming majority of transportation facilities described by this factor in the AHS.

[575] Bailey, C. (2011) Demographic and Social Patterns in Housing Units Near Large Highways and other Transportation Sources. Memorandum to docket.

[576] *http://nces.ed.gov/ccd/*.

[577] Pedde, M.; Bailey, C. (2011) Identification of Schools within 200 Meters of U.S. Primary and Secondary Roads. Memorandum to the docket.

ethnicity, and/or low SES. The emission reductions from these proposed rules would likely result in widespread air quality improvements, but the impact on pollution levels in close proximity to roadways would be most direct. Thus, these proposed rules would likely help in mitigating the disparity in racial, ethnic, and economically-based exposures.

C. Environmental Effects of Non-GHG Pollutants

(1) Visibility

Visibility can be defined as the degree to which the atmosphere is transparent to visible light.[578] Visibility impairment is caused by light scattering and absorption by suspended particles and gases. Visibility is important because it has direct significance to people's enjoyment of daily activities in all parts of the country. Individuals value good visibility for the well-being it provides them directly, where they live and work, and in places where they enjoy recreational opportunities. Visibility is also highly valued in significant natural areas, such as national parks and wilderness areas, and special emphasis is given to protecting visibility in these areas. For more information on visibility see the final 2009 p.m. ISA.[579]

EPA is working to address visibility impairment. Reductions in air pollution from implementation of various programs associated with the Clean Air Act Amendments of 1990 (CAAA) provisions have resulted in substantial improvements in visibility, and will continue to do so in the future. Because trends in haze are closely associated with trends in particulate sulfate and nitrate due to the simple relationship between their concentration and light extinction, visibility trends have improved as emissions of SO_2 and NO_X have decreased over time due to air pollution regulations such as the Acid Rain Program.[580]

In the Clean Air Act Amendments of 1977, Congress recognized visibility's value to society by establishing a national goal to protect national parks and wilderness areas from visibility impairment caused by manmade pollution.[581] In 1999, EPA finalized the regional haze program to protect the visibility in Mandatory Class I Federal areas.[582] There are 156 national parks, forests and wilderness areas categorized as Mandatory Class I Federal areas.[583] These areas are defined in CAA Section 162 as those national parks exceeding 6,000 acres, wilderness areas and memorial parks exceeding 5,000 acres, and all international parks which were in existence on August 7, 1977.

EPA has also concluded that $PM_{2.5}$ causes adverse effects on visibility in other areas that are not protected by the Regional Haze Rule, depending on $PM_{2.5}$ concentrations and other factors such as dry chemical composition and relative humidity (*i.e.,* an indicator of the water composition of the particles). EPA revised the $PM_{2.5}$ standards in December 2012 and established a target level of protection that is expected to be met through attainment of the existing secondary standards for $PM_{2.5}$.

(2) Plant and Ecosystem Effects of Ozone

The welfare effects of ozone can be observed across a variety of scales, *i.e.* subcellular, cellular, leaf, whole plant, population and ecosystem. Ozone effects that begin at small spatial scales, such as the leaf of an individual plant, when they occur at sufficient magnitudes (or to a sufficient degree) can result in effects being propagated along a continuum to larger and larger spatial scales. For example, effects at the individual plant level, such as altered rates of leaf gas exchange, growth and reproduction can, when widespread, result in broad changes in ecosystems, such as productivity, carbon storage, water cycling, nutrient cycling, and community composition.

Ozone can produce both acute and chronic injury in sensitive species depending on the concentration level and the duration of the exposure.[584] In those sensitive species,[585] effects from repeated exposure to ozone throughout the growing season of the plant tend to accumulate, so that even low concentrations experienced for a longer duration have the potential to create chronic stress on vegetation.[586] Ozone damage to sensitive species includes impaired photosynthesis and visible injury to leaves. The impairment of photosynthesis, the process by which the plant makes carbohydrates (its source of energy and food), can lead to reduced crop yields, timber production, and plant productivity and growth. Impaired photosynthesis can also lead to a reduction in root growth and carbohydrate storage below ground, resulting in other, more subtle plant and ecosystems impacts.[587] These latter impacts include increased susceptibility of plants to insect attack, disease, harsh weather, interspecies competition and overall decreased plant vigor. The adverse effects of ozone on areas with sensitive species could potentially lead to species shifts and loss from the affected ecosystems,[588] resulting in a loss or reduction in associated ecosystem goods and services. Additionally, visible ozone injury to leaves can result in a loss of aesthetic value in areas of special scenic significance like national parks and wilderness areas and reduced use of sensitive ornamentals in landscaping.[589]

The Integrated Science Assessment (ISA) for Ozone presents more detailed information on how ozone effects vegetation and ecosystems.[590] The ISA concludes that ambient concentrations of ozone are associated with a number of adverse welfare effects and characterizes the weight of evidence for different effects associated with ozone.[591] The ISA concludes that visible foliar injury effects on vegetation,

[578] National Research Council, (1993). Protecting Visibility in National Parks and Wilderness Areas. National Academy of Sciences Committee on Haze in National Parks and Wilderness Areas. National Academy Press, Washington, DC. This book can be viewed on the National Academy Press Web site at *http://www.nap.edu/books/0309048443/html/.*

[579] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F.

[580] U.S. Environmental Protection Agency (U.S. EPA). 2009. Integrated Science Assessment for Particulate Matter (Final Report). EPA–600–R–08–139F. National Center for Environmental Assessment—RTP Division. December. Available on the Internet at <*http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546*>.

[581] See Section 169(a) of the Clean Air Act.

[582] 64 FR 35714, July 1, 1999.

[583] 62 FR 38680–38681, July 18, 1997.

[584] 73 FR 16486, March 27, 2008.

[585] 73 FR 16491, March 27, 2008. Only a small percentage of all the plant species growing within the U.S. (over 43,000 species have been catalogued in the USDA PLANTS database) have been studied with respect to ozone sensitivity.

[586] The concentration at which ozone levels overwhelm a plant's ability to detoxify or compensate for oxidant exposure varies. Thus, whether a plant is classified as sensitive or tolerant depends in part on the exposure levels being considered. Chapter 9, Section 9.3.4 of U.S. EPA, 2013 Integrated Science Assessment for Ozone and Related Photochemical Oxidants. Office of Research and Development/National Center for Environmental Assessment. U.S. Environmental Protection Agency. EPA 600/R–10/076F.

[587] 73 FR 16492, March 27, 2008.

[588] 73 FR 16493–16494, March 27, 2008, Ozone impacts could be occurring in areas where plant species sensitive to ozone have not yet been studied or identified.

[589] 73 FR 16490–16497, March 27, 2008.

[590] U.S. EPA. Integrated Science Assessment of Ozone and Related Photochemical Oxidants (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–10/076F, 2013. The ISA is available at *http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492#Download.*

[591] The Ozone ISA evaluates the evidence associated with different ozone related health and welfare effects, assigning one of five ''weight of evidence'' determinations: causal relationship, likely to be a causal relationship, suggestive of a causal relationship, inadequate to infer a causal relationship, and not likely to be a causal relationship. For more information on these levels of evidence, please refer to Table II of the ISA.

reduced vegetation growth, reduced productivity in terrestrial ecosystems, reduced yield and quality of agricultural crops, and alteration of below-ground biogeochemical cycles are causally associated with exposure to ozone. It also concludes that reduced carbon sequestration in terrestrial ecosystems, alteration of terrestrial ecosystem water cycling, and alteration of terrestrial community composition are likely to be causally associated with exposure to ozone.

(3) Atmospheric Deposition

Wet and dry deposition of ambient particulate matter delivers a complex mixture of metals (*e.g.,* mercury, zinc, lead, nickel, aluminum, and cadmium), organic compounds (*e.g.,* polycyclic organic matter, dioxins, and furans) and inorganic compounds (*e.g.,* nitrate, sulfate) to terrestrial and aquatic ecosystems. The chemical form of the compounds deposited depends on a variety of factors including ambient conditions (*e.g.,* temperature, humidity, oxidant levels) and the sources of the material. Chemical and physical transformations of the compounds occur in the atmosphere as well as the media onto which they deposit. These transformations in turn influence the fate, bioavailability and potential toxicity of these compounds.

Adverse impacts to human health and the environment can occur when particulate matter is deposited to soils, water, and biota.[592] Deposition of heavy metals or other toxics may lead to the human ingestion of contaminated fish, impairment of drinking water, damage to terrestrial, freshwater and marine ecosystem components, and limits to recreational uses. Atmospheric deposition has been identified as a key component of the environmental and human health hazard posed by several pollutants including mercury, dioxin and PCBs.[593]

The ecological effects of acidifying deposition and nutrient enrichment are detailed in the Integrated Science Assessment for Oxides of Nitrogen and Sulfur-Ecological Criteria.[594] Atmospheric deposition of nitrogen and sulfur contributes to acidification, altering biogeochemistry and affecting animal and plant life in terrestrial and aquatic ecosystems across the United States. The sensitivity of terrestrial and aquatic ecosystems to acidification from nitrogen and sulfur deposition is predominantly governed by geology. Prolonged exposure to excess nitrogen and sulfur deposition in sensitive areas acidifies lakes, rivers and soils. Increased acidity in surface waters creates inhospitable conditions for biota and affects the abundance and biodiversity of fishes, zooplankton and macroinvertebrates and ecosystem function. Over time, acidifying deposition also removes essential nutrients from forest soils, depleting the capacity of soils to neutralize future acid loadings and negatively affecting forest sustainability. Major effects in forests include a decline in sensitive tree species, such as red spruce (*Picea rubens*) and sugar maple (*Acer saccharum*). In addition to the role nitrogen deposition plays in acidification, nitrogen deposition also leads to nutrient enrichment and altered biogeochemical cycling. In aquatic systems increased nitrogen can alter species assemblages and cause eutrophication. In terrestrial systems nitrogen loading can lead to loss of nitrogen sensitive lichen species, decreased biodiversity of grasslands, meadows and other sensitive habitats, and increased potential for invasive species. For a broader explanation of the topics treated here, refer to the description in Chapter 8.1.2.3 of the RIA.

Building materials including metals, stones, cements, and paints undergo natural weathering processes from exposure to environmental elements (*e.g.,* wind, moisture, temperature fluctuations, sunlight, etc.). Pollution can worsen and accelerate these effects. Deposition of PM is associated with both physical damage (materials damage effects) and impaired aesthetic qualities (soiling effects). Wet and dry deposition of PM can physically affect materials, adding to the effects of natural weathering processes, by potentially promoting or accelerating the corrosion of metals, by degrading paints and by deteriorating building materials such as stone, concrete and marble.[595] The effects of PM are exacerbated by the presence of acidic gases and can be additive or synergistic due to the complex mixture of pollutants in the air and surface characteristics of the material. Acidic deposition has been shown to have an effect on materials including zinc/galvanized steel and other metal, carbonate stone (as monuments and building facings), and surface coatings (paints).[596] The effects on historic buildings and outdoor works of art are of particular concern because of the uniqueness and irreplaceability of many of these objects.

(4) Environmental Effects of Air Toxics

Emissions from producing, transporting and combusting fuel contribute to ambient levels of pollutants that contribute to adverse effects on vegetation. Volatile organic compounds, some of which are considered air toxics, have long been suspected to play a role in vegetation damage.[597] In laboratory experiments, a wide range of tolerance to VOCs has been observed.[598] Decreases in harvested seed pod weight have been reported for the more sensitive plants, and some studies have reported effects on seed germination, flowering and fruit ripening. Effects of individual VOCs or their role in conjunction with other stressors (*e.g.,* acidification, drought, temperature extremes) have not been well studied. In a recent study of a mixture of VOCs including ethanol and toluene on herbaceous plants, significant effects on seed production, leaf water content and photosynthetic efficiency were reported for some plant species.[599]

Research suggests an adverse impact of vehicle exhaust on plants, which has in some cases been attributed to aromatic compounds and in other cases to nitrogen oxides.[600] [601] [602]

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[592] U.S. EPA. Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, 2009.

[593] U.S. EPA. (2000). Deposition of Air Pollutants to the Great Waters: Third Report to Congress. Office of Air Quality Planning and Standards. EPA–453/R–00–0005.

[594] NO_X and SO_X secondary ISA[594] U.S. EPA. Integrated Science Assessment (ISA) for Oxides of Nitrogen and Sulfur Ecological Criteria (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/082F, 2008.

[595] U.S. Environmental Protection Agency (U.S. EPA). 2009. Integrated Science Assessment for Particulate Matter (Final Report). EPA–600–R–08–139F. National Center for Environmental Assessment—RTP Division. December. Available on the Internet at *<http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546>*.

[596] Irving, P.M., e.d. 1991. Acid Deposition: State of Science and Technology, Volume III, Terrestrial, Materials, Health, and Visibility Effects, The U.S. National Acid Precipitation Assessment Program, Chapter 24, page 24–76.

[597] U.S. EPA. (1991). Effects of organic chemicals in the atmosphere on terrestrial plants. EPA/600/3–91/001.

[598] Cape JN, ID Leith, J Binnie, J Content, M Donkin, M Skewes, DN Price AR Brown, AD Sharpe. (2003). Effects of VOCs on herbaceous plants in an open-top chamber experiment. Environ. Pollut. 124:341–343.

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[600] Viskari E–L. (2000). Epicuticular wax of Norway spruce needles as indicator of traffic pollutant deposition. Water, Air, and Soil Pollut. 121:327–337.

[601] Ugrekhelidze D, F Korte, G Kvesitadze. (1997). Uptake and transformation of benzene and toluene by plant leaves. Ecotox. Environ. Safety 37:24–29.

[602] Kammerbauer H, H Selinger, R Rommelt, A Ziegler-Jons, D Knoppik, B Hock. (1987). Toxic

D. Air Quality Impacts of Non-GHG Pollutants

(1) Current Concentrations of Non-GHG Pollutants

Nationally, levels of $PM_{2.5}$, ozone, NO_X, SO_X, CO and air toxics are declining.[603] However, as of July 2, 2014 approximately 147 million people lived in counties designated nonattainment for one or more of the NAAQS, and this figure does not include the people living in areas with a risk of exceeding the NAAQS in the future.[604] The most recent available data indicate that the majority of Americans continue to be exposed to ambient concentrations of air toxics at levels which have the potential to cause adverse health effects.[605] In addition, populations who live, work, or attend school near major roads experience elevated exposure concentrations to a wide range of air pollutants.[606]

EPA recognizes that states and local areas are particularly concerned about the challenges of reducing NO_X and attaining as well as maintaining the ozone NAAQS. States and local areas are required to adopt emission control measures to attain the NAAQS. States may then choose to seek redesignation to attainment and if they do so they must demonstrate that control measures are in place sufficient to maintain the NAAQS for ten years (and eight years later, a similar demonstration is required for another ten-year period). The most recent revision to the ozone standards was in 2008; the previous 8-hour ozone standards were set in 1997. Attaining and maintaining the NAAQS has been challenging for some areas in the past, and EPA has recently issued a proposal that would strengthen the ozone NAAQS (79 Fed. Reg 75,234, Dec. 17, 2014).

(2) Impacts of Proposed Standards on Future Ambient Concentrations of Non-GHG Pollutants

Full-scale photochemical air quality modeling is necessary to accurately project levels of criteria pollutants and air toxics. For the final rulemaking, national-scale air quality modeling analyses will be performed to analyze the impacts of the standards on $PM_{2.5}$, ozone, NO_2, and selected air toxics (*i.e.,* benzene, formaldehyde, acetaldehyde, naphthalene, acrolein and 1,3-butadiene). The length of time needed to prepare the necessary emissions inventories, in addition to the processing time associated with the modeling itself, has precluded us from performing air quality modeling for this proposal.

Section VIII.A of the preamble presents projections of the changes in criteria pollutant and air toxics emissions due to the proposed vehicle standards; the basis for those estimates is set out in Chapter 5 of the draft RIA. NHTSA also provides its projections in Chapter 4 of its DEIS. The atmospheric chemistry related to ambient concentrations of $PM_{2.5}$, ozone and air toxics is very complex, and making predictions based solely on emissions changes is extremely difficult. However, based on the magnitude of the emissions changes predicted to result from the proposed standards, the agencies expect that there will be improvements in ambient air quality, pending more comprehensive analyses for the final rulemaking.

For the final rulemaking national-scale air quality modeling analyses will be performed to estimate future year ambient ozone, NO_2, and $PM_{2.5}$ concentrations, air toxics concentrations, visibility levels and nitrogen and sulfur deposition levels for 2040. The agencies intend to use a 2011-based Community Multi-scale Air Quality (CMAQ) modeling platform as the tool for the air quality modeling. The CMAQ modeling system is a comprehensive three-dimensional grid-based Eulerian air quality model designed to estimate the formation and fate of oxidant precursors, primary and secondary PM concentrations and deposition, and air toxics, over regional and urban spatial scales (*e.g.,* over the contiguous United States).[607 608 609 610] The CMAQ model is a well-known and well-established tool and is commonly used by EPA for regulatory analyses, by States in developing attainment demonstrations for their State Implementation Plans, and in numerous other national and international applications.[611 612 613 614] The CMAQ model version 5.0 was most recently peer-reviewed in September of 2011 for the U.S. EPA.[615] CMAQ includes numerous science modules that simulate the emission, production, decay, deposition and transport of organic and inorganic gas-phase and particle-phase pollutants in the atmosphere. This 2011 multi-pollutant modeling platform used the most recent multi-pollutant CMAQ code available at the time of air quality modeling (CMAQ version 5.0.2; multipollutant version).[616] CMAQ v5.0.2 reflects updates to version 5.0 to improve the underlying science algorithms as well as include new diagnostic/scientific

components of motor vehicle emissions for the spruce Picea abies. Environ. Pollut. 48:235–243.

603 U.S. EPA, 2011. Our Nation's Air: Status and Trends through 2010. EPA–454/R–12–001. February 2012. Available at: *http://www.epa.gov/airtrends/2011/.*

604 Data come from Summary Nonattainment Area Population Exposure Report, current as of July 2, 2014 at: *http://www.epa.gov/oar/oaqps/greenbk/popexp.html* and contained in Docket EPA–HQ–OAR–2014–0827.

605 U.S. EPA. (2011) Summary of Results for the 2005 National-Scale Assessment. *www.epa.gov/ttn/atw/nata2005/05pdf/sum_results.pdf.*

606 Health Effects Institute Panel on the Health Effects of Traffic-Related Air Pollution. (2010) Traffic-related air pollution: a critical review of the literature on emissions, exposure, and health effects. HEI Special Report 17. Available at *http://www.healtheffects.org*].

607 U.S. Environmental Protection Agency, Byun, D.W., and Ching, J.K.S., Eds, 1999. Science algorithms of EPA Models-3 Community Multiscale Air Quality (CMAQ modeling system, EPA/600/R–99/030, Office of Research and Development). Docket EPA–HQ–OAR–2010–0162

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609 Dennis, R.L., Byun, D.W., Novak, J.H., Galluppi, K.J., Coats, C.J., and Vouk, M.A., 1996. The next generation of integrated air quality modeling: EPA's Models-3, Atmospheric Environment, 30, 1925–1938. Docket EPA–HQ–OAR–2010–0162

610 Carlton, A., Bhave, P., Napelnok, S., Edney, E., Sarwar, G., Pinder, R., Pouliot, G., and Houyoux, M. *Model Representation of Secondary Organic Aerosol in CMAQv4.7.* Ahead of Print in Environmental Science and Technology. Accessed at: *http://pubs.acs.org/doi/abs/10.1021/es100636q?prevSearch=CMAQ&searchHistoryKey* Docket EPA–HQ–OAR–2010–0162.

611 U.S. EPA (2007). Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone. EPA document number 442/R–07–008, July 2007. Docket EPA–HQ–OAR–2010–0162

612 Hogrefe, C., Biswas, J., Lynn, B., Civerolo, K., Ku, J.Y., Rosenthal, J., et al. (2004). Simulating regional-scale ozone climatology over the eastern United States: model evaluation results. *Atmospheric Environment, 38(17),* 2627–2638.

613 United States Environmental Protection Agency. (2008). Technical support document for the final locomotive/marine rule: Air quality modeling analyses. Research Triangle Park, N.C.: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division.

614 Lin, M., Oki, T., Holloway, T., Streets, D.G., Bengtsson, M., Kanae, S., (2008). Long range transport of acidifying substances in East Asia Part I: Model evaluation and sensitivity studies. Atmospheric Environment, 42(24), 5939–5955.

615 Brown, N., Allen, D., Amar, P., Kallos, G., McNider, R., Russell, A., Stockwell, W. (September 2011). Final Report: Fourth Peer Review of the CMAQ Model, NERL/ORD/EPA. U.S. EPA, Research Triangle Park, NC. *http://www.epa.gov/asmdnerl/Reviews/2011_CMAQ_Review_FinalReport.pdf.* It is available from the Community Modeling and Analysis System (CMAS) as well as previous peer-review reports at: *http://www.cmascenter.org.*

616 CMAQ version 5.0.2 was released in April 2014. It is available from the Community Modeling and Analysis System (CMAS) Web site: *http://www.cmascenter.org.*

modules which are detailed at *http://www.cmascenter.org*.[617 618 619]

IX. Economic and Other Impacts

This section presents the costs, benefits and other economic impacts of the proposed Phase 2 standards. It is important to note that NHTSA's proposed fuel consumption standards and EPA's proposed GHG standards would both be in effect, and each would lead to average fuel efficiency increases and GHG emission reductions.

The net benefits of the proposed Phase 2 standards consist of the effects of the program on:

- The vehicle program costs (costs of complying with the vehicle CO_2 and fuel consumption standards),
- changes in fuel expenditures associated with reduced fuel use resulting from more efficient vehicles and increased fuel use associated with the ''rebound'' effect, both of which result from the program,
- the economic value of reductions in GHGs,
- the economic value of reductions in non-GHG pollutants,
- costs associated with increases in noise, congestion, and accidents resulting from increased vehicle use,
- savings in drivers' time from less frequent refueling,
- benefits of increased vehicle use associated with the ''rebound'' effect,
- the economic value of improvements in U.S. energy security.

The benefits and costs of these rules are analyzed using 3 percent and 7 percent discount rates, consistent with current OMB guidance.[620] These rates are intended to represent consumers' preference for current over future consumption (3 percent), and the real rate of return on private investment (7 percent) which indicates the opportunity cost of capital. However, neither of these rates necessarily represents the discount rate that individual decision-makers use.

The program may also have other economic effects that are not included here. The agencies seek comment on whether any costs or benefits are omitted from this analysis, so that they can be explicitly recognized in the final rules. In particular, as discussed in Sections III through VI of this preamble and in Chapter 2 of the draft RIA, the technology cost estimates developed here take into account the costs to hold other vehicle attributes, such as size and performance, constant. With these assumptions, and because welfare losses represent monetary estimates of how much buyers would have to be compensated to be made as well off as they would have been in the absence of this regulation,[621] price increases for new vehicles measure the welfare losses to the vehicle buyers.[622] If the full technology cost gets passed along to the buyer as an increase in price, the technology cost thus measures the primary welfare loss of the standards, including impacts on buyers. Increasing fuel efficiency would have to lead to other changes in the vehicles that buyers find undesirable for there to be additional welfare losses that are not included in the technology costs.

As the 2012–2016 and 2017–2025 light-duty GHG/CAFE rules discussed, if other vehicle attributes are not held constant, then the technology cost estimates do not capture the losses to vehicle buyers associated with these changes.[623] The light-duty rules also discussed other potential issues that could affect the calculation of the welfare impacts of these types of changes, such as aspects of buyers' behavior that might affect the demand for technology investments, uncertainty in buyers' investment horizons, and the rate at which truck owners trade off higher vehicle purchase price against future fuel savings. The agencies seek comments, including supporting data and quantitative analyses, of any additional impacts of the proposed standards on vehicle attributes and performance, or other potential aspects that could positively or negatively affect the welfare implications of this proposed rulemaking.

Where possible, we identify the uncertain aspects of these economic impacts and attempt to quantify them (*e.g.,* sensitivity ranges associated with quantified and monetized GHG impacts; range of dollar-per-ton values to monetize non-GHG health benefits; uncertainty with respect to learning and markups). For HD pickups and vans, the agencies explicitly analyzed the uncertainty surrounding its estimates of the economic impacts from requiring higher fuel efficiency in Preamble Section VI. The agencies have also examined the sensitivity of oil prices on fuel expenditures; results of this sensitivity analysis can be found in Chapter 8 of the RIA. NHTSA's draft EIS also characterizes the uncertainty in economic impacts associated with the HD national program. For other impacts, however, there is inadequate information to inform a thorough, quantitative assessment of uncertainty. EPA and NHTSA continue to work toward developing a comprehensive strategy for characterizing the aggregate impact of uncertainty in key elements of its analyses and we will continue to work to refine these uncertainty analyses in the future as time and resources permit. The agencies seek comments on the methods and assumptions used to quantify uncertainty in this analysis, as well as comments on methods and data that might inform relevant uncertainty analyses not quantified in this analysis.

This and other sections of the preamble address Section 317 of the Clean Air Act on economic analysis. Section IX.L addresses Section 321 of the Clean Air Act on employment analysis. The total monetized benefits and costs of the program are summarized in Section IX.K for the preferred alternative and in Section X for all alternatives.

A. Conceptual Framework

The HD Phase 2 proposed standards would implement both the 2007 Energy Independence and Security Act requirement that NHTSA establish fuel

[617] Community Modeling and Analysis System (CMAS) Web site: *http://www.cmascenter.org,* RELEASE_NOTES for CMAQv5.0—February 2012.

[618] Community Modeling and Analysis System (CMAS) Web site: *http://www.cmascenter.org,* RELEASE_NOTES for CMAQv5.0.1—July 2012.

[619] Community Modeling and Analysis System (CMAS) Web site: *http://www.cmascenter.org.* CMAQ version 5.0.2 (April 2014 release) Technical Documentation.—May 2014.

[620] The range of Social Cost of Carbon ($SC–CO_2$) values uses several discount rates because the literature shows that the $SC–CO_2$ is quite sensitive to assumptions about the discount rate, and because no consensus exists on the appropriate rate to use in an intergenerational context (where costs and benefits are incurred by different generations). Refer to Section F.1 for more information.

[621] This approach describes the economic concept of compensating variation, a payment of money after a change that would make a consumer as well off after the change as before it. A related concept, equivalent variation, estimates the income change that would be an alternative to the change taking place. The difference between them is whether the consumer's point of reference is her welfare before the change (compensating variation) or after the change (equivalent variation). In practice, these two measures are typically very close together.

[622] Indeed, it is likely to be an overestimate of the loss to the consumer, because the buyer has choices other than buying the same vehicle with a higher price; she could choose a different vehicle, or decide not to buy a new vehicle. The buyer would choose one of those options only if the alternative involves less loss than paying the higher price. Thus, the increase in price that the buyer faces would be the upper bound of loss of consumer welfare, unless there are other changes to the vehicle due to the fuel efficiency improvements that make the vehicle less desirable to consumers.

[623] Environmental Protection Agency and Department of Transportation, ''Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule,'' 75 FR 25324, May 7, 2010, especially Sections III.H.1 (25510–25513) and IV.G.6 (25651–25657); Environmental Protection Agency and Department of Transportation, ''2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule,'' 77 FR 62624, October 15, 2012, especially Sections III.H.1 (62913–62919) and IV.G.5.a (63102–63104).

efficiency standards for medium- and heavy-duty vehicles and the Clean Air Act requirement that EPA adopt technology-based standards to control pollutant emissions from motor vehicles and engines contributing to air pollution that endangers public health and welfare. NHTSA's statutory mandate is intended to further the agency's long-standing goals of reducing U.S. consumption and imports of petroleum energy to improve the nation's energy security.

From an economics perspective, government actions to improve our nation's energy security and to protect our nation from the potential threats of climate change address ''externalities,'' or economic consequences of decisions by individuals and businesses that extend beyond those who make these decisions. For example, users of transportation fuels increase the entire U.S. economy's risk of having to make costly adjustments due to rapid increases in oil prices, but these users generally do not consider such costs when they decide to consume more fuel.

Similarly, consuming transportation fuel also increases emissions of greenhouse gases and other more localized air pollutants that occur when fuel is refined, distributed, and consumed. Some of these emissions increase the likelihood and severity of potential climate-related economic damages, and others cause economic damages by adversely affecting human health. The need to address these external costs and other adverse effects provides a well-established economic rationale that supports the statutory direction given to government agencies to establish regulatory programs that reduce the magnitude of these adverse effects at reasonable costs.

The proposed Phase 2 standards would require manufacturers of new heavy-duty vehicles, including trailers (HDVs), to improve the fuel efficiency of the products that they produce. As HDV users purchase and operate these new vehicles, they would consume significantly less fuel, in turn reducing U.S. petroleum consumption and imports as well as emissions of GHGs and other air pollutants. Thus, as a consequence of the agencies' efforts to meet our statutory obligations to improve U.S. energy security and EPA's obligation to issue standards ''to regulate emissions of the deleterious pollutant . . . from motor vehicles'' that endangers public health and welfare,[624] the proposed fuel efficiency and GHG emission standards would also reduce HDV operators' outlays for fuel purchases. These fuel savings are one measure of the proposed rule's effectiveness in promoting NHTSA's statutory goal of conserving energy, as well as EPA's obligation to assess the cost of standards under section 202(a)(1) and (2) of the Clean Air Act. Although these savings are not the agencies' primary motivation for adopting higher fuel efficiency standards, these substantial fuel savings represent significant additional economic benefits of this proposal.

Potential savings in fuel costs would appear to offer HDV buyers strong incentives to pay higher prices for vehicles that feature technology or equipment that reduces fuel consumption. These potential savings would also appear to offer HDV manufacturers similarly strong incentives to produce more fuel-efficient vehicles. Economic theory suggests that interactions between vehicle buyers and sellers in a normally-functioning competitive market would lead HDV manufacturers to incorporate all technologies that contribute to lower net costs into the vehicles they offer, and buyers to purchase them willingly. Nevertheless, many readily available technologies that appear to offer cost-effective increases in HDV fuel efficiency (when evaluated over their expected lifetimes using conventional discount rates) have not been widely adopted, despite their potential to repay buyers' initial investments rapidly.

This economic situation is commonly known as the ''energy efficiency gap'' or ''energy paradox.'' This situation is perhaps more challenging to understand with respect to the heavy-duty sector versus the light-duty vehicle sector. Unlike light-duty vehicles—which are purchased and used mainly by individuals and households—the vast majority of HDVs are purchased and operated by profit-seeking businesses for which fuel costs represent a substantial operating expense. Nevertheless, on the basis of evidence reviewed below, the agencies believe that a significant number of fuel efficiency improving technologies would remain far less widely adopted in the absence of these proposed standards.

Economic research offers several possible explanations for why the prospect of these apparent savings might not lead HDV manufacturers and buyers to adopt technologies that would be expected to reduce HDV operating costs. Some of these explanations involve failures of the HDV market for reasons other than the externalities caused by producing and consuming fuel. These include situations where information about the performance of fuel economy technologies is incomplete, costly to obtain, or available only to one party to a transaction (or ''asymmetrical''), as well as behavioral rigidities in either the HDV manufacturing or HDV-operating industries, such as standardized or inflexibly administered operating procedures, or requirements of other regulations on HDVs. Other explanations for the limited use of apparently cost-effective technologies that do not involve market failures include HDV operators' concerns about the performance, reliability, or maintenance requirements of new technology under the demands of everyday use, uncertainty about the fuel savings they will actually realize, and questions about possible effects on carrying capacity or other aspects of HDVs' utility.

In the HD Phase 1 rulemaking (which, in contrast to these proposed standards, did not apply to trailers), the agencies raised five hypotheses that might explain this energy efficiency gap or paradox:

- Imperfect information in the new vehicle market: Information available to prospective buyers about the effectiveness of some fuel-saving technologies for new vehicles may be inadequate or unreliable. If reliable information on their effectiveness in reducing fuel consumption is unavailable or difficult to obtain, HDV buyers will understandably be reluctant to pay higher prices to purchase vehicles equipped with unproven technologies.
- Imperfect information in the resale market: Buyers in the used vehicle market may not be willing to pay adequate premiums for more fuel efficient vehicles when they are offered for resale to ensure that buyers of new vehicles can recover the remaining value of their original investment in higher fuel efficiency. The prospect of an inadequate return on their original owners' investments in higher fuel efficiency may contribute to the short payback periods that buyers of new vehicles appear to demand.[625]

[624] *State of Massachusetts* v. *EPA,* 549 U.S. at 533.

[625] Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles; National Research Council; Transportation Research Board (2010). ''Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,'' (hereafter, ''NAS 2010''). Washington, DC. The National Academies Press. Available electronically from the National Academies Press Web site at *http://www.nap.edu/catalog.php?record_id=12845* (accessed September 10, 2010).

• Principal-agent problems causing split incentives: An HDV buyer may not be directly responsible for its future fuel costs, or the individual who will be responsible for fuel costs may not participate in the HDV purchase decision. In these cases, the signal to invest in higher fuel efficiency normally provided by savings in fuel costs may not be transmitted effectively to HDV buyers, and the incentives of HDV buyers and fuel buyers will diverge, or be ''split.'' The trailers towed by heavy-duty tractors, which are typically not supplied by the tractor manufacturer or seller, present an obvious potential situation of split incentives that was not addressed in the HD Phase 1 rulemaking, but it may apply in this rulemaking. If there is inadequate pass-through of price signals from trailer users to their buyers, then low adoption of fuel-saving technologies may result.

• Uncertainty about future fuel cost savings: HDV buyers may be uncertain about future fuel prices, or about maintenance costs and reliability of some fuel efficiency technologies. Buyers may react to this uncertainty by implicitly discounting potential future savings at rates above discount rates used in this analysis. In contrast, the costs of fuel-saving or maintenance-reducing technologies are immediate and thus not subject to discounting. In this situation, potential variability about buyers' expected returns on capital investments to achieve higher fuel efficiency may shorten the payback period—the time required to repay those investments—they demand in order to make them.

• Adjustment and transactions costs: Potential resistance to new technologies—stemming, for example, from drivers' reluctance or slowness to adjust to changes in the way vehicles operate—may slow or inhibit new technology adoption. If a conservative approach to new technologies leads HDV buyers to adopt them slowly, then successful new technologies would be adopted over time without market intervention, but only with potentially significant delays in achieving the fuel saving, environmental, and energy security benefits they offer. There also may be costs associated with training drivers to realize potential fuel savings enabled by new technologies, or with accelerating fleet operators' scheduled fleet turnover and replacement to hasten their acquisition of vehicles equipped with these technologies.

Some of these explanations imply failures in the private market for fuel-saving technology beyond the externalities caused by producing and consuming fuel, while others suggest that complications in valuing or adapting to technologies that reduce fuel consumption may partly explain buyers' hesitance to purchase more fuel-efficient vehicles. In either case, adopting this proposed rule would provide regulatory certainty and generate important economic benefits in addition to reducing externalities.

Since the HD Phase 1 rulemaking, new research has provided further insight into potential barriers to adoption of fuel-saving technologies. Several studies utilized focus groups and interviews involving small numbers of participants, who were people with time and inclination to join such studies, rather than selected at random.[626] As a result, the information from these groups is not necessarily representative of the industry as a whole. While these studies cannot provide conclusive evidence about how all HDV buyers make their decisions, they do describe issues that arise for those that participated.

One common theme that emerges from these studies is the inability of HDV buyers to obtain reliable information about the fuel savings, reliability, and maintenance costs of technologies that improve fuel efficiency. In many product markets, such as consumer electronics, credible reviews and tests of product performance are readily available to potential buyers. In the trucking industry, however, the performance of fuel-saving technology is likely to depend on many firm-specific attributes, including the intensity of HDV use, the typical distance and routing of HDV trips, driver characteristics, road conditions, regional geography and traffic patterns.

As a result, businesses that operate HDVs have strong preferences for testing fuel-saving technologies ''in-house'' because they are concerned that their patterns of vehicle use may lead to different results from those reported in published information. Businesses with less capability to do in-house testing often seek information from peers, yet often remain skeptical of its applicability due to differences in the nature of their operations. One source of imperfect information is the lack of availability of certain technologies from preferred suppliers. HDV buyers often prefer to have technology or equipment installed by their favored original equipment manufacturers. However, some technologies may not be available through these preferred sources, or may be available only as after-market installations from third parties (Aarnink et al. 2012, Roeth et al. 2013).

Although these studies appear to show that information in the new HDV market is often limited or viewed as unreliable, the evidence for imperfect information in the market for used HDVs is mixed. On the one hand, some studies noted that fuel-saving technology is often not valued or demanded in the used vehicle market, because of imperfect information about its benefits, or greater mistrust of its performance among buyers in the used vehicle market than among buyers of new vehicles. The lack of demand might also be due to the intended use of the used HDV, which may not require or reward the presence of certain fuel-saving technologies. In other cases, however, fuel-saving technology can lead to a premium in the used market, as for instance to meet the more stringent requirements for HDVs operating in California.

All of the recent research identifies split incentives, or principal-agent problems, as a potential barrier to technology adoption. These occur when those responsible for investment decisions are different from the main beneficiaries of the technology. For instance, businesses that own and lease trailers to HDV operators may not have an incentive to invest in trailer-specific fuel-saving technology, since they do not collect the savings from the lower fuel costs that result. Vernon and Meier (2012) estimate that 23 percent of trailers may be exposed to this kind of principal-agent problem, although they do not quantify its financial significance.[627]

Split incentives can also exist when the HDV driver is not responsible for paying fuel costs. Some technologies require additional effort, training, or changes in driving behavior to achieve their promised fuel savings; drivers who do not pay for fuel may be reluctant to undertake those changes, thus reducing the fuel-saving benefits from the perspective of the individual or company paying for the fuel. For

[626] Klemick, Heather, Elizabeth Kopits, Keith Sargent, and Ann Wolverton (2014). ''Heavy-Duty Trucking and the Energy Efficiency Paradox.'' US EPA NCEE Working Paper Series. Working Paper 14–02; Roeth, Mike, Dave Kircher, Joel Smith, and Rob Swim (2013). ''Barriers to the Increased Adoption of Fuel Efficiency Technologies in the North American On-Road Freight Sector.'' NACFE report for the International Council on Clean Transportation; Aarnink, Sanne, Jasper Faber, and Eelco den Boer (2012). ''Market Barriers to Increased Efficiency in the European On-road Freight Sector.'' CE Delft report for the International Council on Clean Transportation.

[627] Vernon, David and Alan Meier (2012). ''Identification and quantification of principal-agent problems affecting energy efficiency investments and use decisions in the trucking industry.'' Energy Policy, 49(C), pp. 266–273.

instance, drivers might not consistently deploy boat-tails equipped on trailers to improve vehicle aerodynamics.[628] Vernon and Meier also calculate that 91 percent of HDV fuel use is subject to this form of principal-agent problem, although they do not estimate how much it might reduce fuel savings to those who are paying for the fuel.

The studies based on focus groups and interviews (Klemick et al. 2013, Aarnink et al. 2012, Roeth et al. 2013) provide mixed evidence on the severity of the split-incentive problem. Focus groups often do identify diverging incentives between drivers and the decision-makers responsible for purchasing vehicles, and economics literature recognizes that this split incentive can be a barrier to adopting new technology. Aarnink et al. (2012) and Roeth et al. (2013) cite examples of split incentives involving trailers and fuel surcharges, although the latter also cites other examples where these same issues do not lead to split incentives.

In an effort to minimize problems that can arise from split incentives, many businesses that operate HDVs also train drivers in the use of specific technologies or to modify their driving behavior in order to improve fuel efficiency, while some also offer financial incentives to their drivers to conserve fuel. All of these options can help to reduce the split incentive problem, although they may not be effective where it arises from different ownership of combination tractors and trailers.

Uncertainty about future costs for fuel and maintenance, or about the reliability of new technology, also appears to be a significant obstacle that can slow the adoption of fuel-saving technologies. These examples illustrate the problem of uncertain or unreliable information about the actual performance of fuel efficiency technology discussed above. In addition, businesses that operate HDVs may be concerned about how reliable new technologies will prove to be on the road, and whether significant additional maintenance costs or equipment malfunctions that result in costly downtime could occur. Roeth et al. (2013) and Klemick et al. (2013) both document the short payback periods that HDV buyers require on their investments—usually about 2 years—which may be partly attributable to these uncertainties.

These studies also provide some support for the view that adjustment and transactions costs may impede HDV buyers from investing in higher fuel efficiency. As discussed above, several studies note that HDV buyers are less likely to select new technology when it is not available from their preferred manufacturers. Some technologies are only available as after-market additions, which can add other costs to adopting them.

Some studies also cite driver acceptance of new equipment or technologies as a barrier to their adoption. HDV driver turnover is high in the U.S., and businesses that operate HDVs are concerned about retaining their best drivers. Therefore, they may avoid technologies that require significant new training or adjustments in driver behavior. For some technologies that can be used to meet the proposed standards, such as automatic tire inflation systems, training costs are likely to be minimal. Other technologies such as stop-start systems, however, may require drivers to adjust their expectations about vehicle operation, and it is difficult for the agencies to anticipate how drivers will respond to such changes.[629]

In addition to these factors, the studies considered other possible explanations for HDV buyers' apparent reluctance or slowness to invest in fuel-saving equipment or technology. Financial constraints—access to lending sources willing to finance purchases of more expensive vehicles—do not appear to be a problem for the medium- and large-sized businesses participating in Klemick et al.'s (2013) study. However, Roeth et al. (2013) noted that access to capital can be a significant challenge to smaller or independent businesses, and that price is always a concern to buyers. In general, businesses that operate HDVs face a range of competing uses for available capital other than investing in fuel-saving technologies, and may assign higher priority to these other uses, even when investing in higher fuel efficiency HDVs appears to promise adequate financial returns.

Other potentially important barriers to the adoption of measures that improve fuel efficiency may arise from ''network externalities,'' where the benefits to new users of a technology depend on how many others have already adopted it. One example where network externalities seem likely to arise is the market for natural gas-fueled HDVs: The limited availability of refueling stations may reduce potential buyers' willingness to purchase natural gas-fueled HDVs, while the small number of such HDVs in-use does not provide sufficient economic incentive to construct more natural gas refueling stations.

Some businesses that operate HDVs may also be concerned about the difficulty in locating repair facilities or replacement parts, such as single-wide tires, wherever their vehicles operate. When a technology has been widely adopted, then it is likely to be serviceable even in remote or rural places, but until it becomes widely available, its early adopters may face difficulties with repairs or replacements. By accelerating the widespread adoption of these technologies, the proposed standards may assist in overcoming these difficulties.

As discussed previously, the lack of availability of fuel-saving technologies from preferred manufactures can also be a significant barrier to adoption (Roeth et al. 2013). Manufacturers may be hesitant to offer technologies for which there is not strong demand, especially if the technologies require significant research and development expenses and other costs of bringing the technology to a market of uncertain demand.

Roeth et al. (2013) also noted that it can take years, and sometimes as much as a decade, for a specific technology to become available from all manufacturers. Many manufacturers prefer to observe the market and follow other manufacturers rather than be the first to market with a specific technology. The ''first-mover disadvantage'' has been recognized in other research where the ''first-mover'' pays a higher proportion of the costs of developing technology, but loses the long-term advantage when other businesses follow quickly.[630] In this way, there may be barriers to innovation on the supply side that result in lower adoption rates of fuel-efficiency technology than would be optimal.

In summary, the agencies recognize that businesses that operate HDVs are under competitive pressure to reduce operating costs, which should compel

[628] Some boat-tails are being developed with technology to open them automatically when the trailer reaches a suitable speed, to reduce this problem.

[629] The distinction between simply requiring drivers (or mechanics) to adjust their expectations and compromises in vehicle performance or utility is subtle. While the former may not impose significant compliance costs in the long run, the latter would represent additional economic costs of complying with the standard.

[630] Blumstein, Carl and Margaret Taylor (2013). ''Rethinking the Energy-Efficiency Gap: Producers, Intermediaries, and Innovation,'' Energy Institute at Haas Working Paper 243, University of California at Berkeley; Tirole, Jean (1998). *The Theory of Industrial Organization.* Cambridge, MA: MIT Press, pp.400, 402. This first-mover disadvantage must large enough to overcome the incentive normally offered by the potential to for first movers to earn unusually high (but temporary) profit levels.

HDV buyers to identify and rapidly adopt cost-effective fuel-saving technologies. Outlays for labor and fuel generally constitute the two largest shares of HDV operating costs, depending on the price of fuel, distance traveled, type of HDV, and commodity transported (if any), so businesses that operate HDVs face strong incentives to reduce these costs.[631] [632]

However, the short payback periods that buyers of new HDVs appear to require suggest that some combination of uncertainty about future cost savings, transactions costs, and imperfectly functioning markets impedes this process. Markets for both new and used HDVs may face these problems, although it is difficult to assess empirically the degree to which they actually do. Even if the benefits from widespread adoption of fuel-saving technologies exceed their costs, their use may remain limited or spread slowly because their early adopters bear a disproportionate share of those costs. In this case, the proposed standards may help to overcome such barriers by ensuring that these measures would be widely adopted.

Providing information about fuel-saving technologies, offering incentives for their adoption, and sharing HDV operators' real-world experiences with their performance through voluntary programs such as EPA's SmartWay Transport Partnership should assist in the adoption of new cost-saving technologies. Nevertheless, other barriers that impede the diffusion of new technologies are likely to remain. Buyers who are willing to experiment with new technologies expect to find cost savings, but those savings may be difficult to verify or replicate. As noted previously, because benefits from employing these technologies are likely to vary with the characteristics of individual routes and traffic patterns, buyers of new HDVs may find it difficult to identify or verify the effects of fuel-saving technologies in their operations. Risk-averse buyers may also avoid new technologies out of concerns over the possibility of inadequate returns on their investments, or with other possible adverse impacts.

Some HDV manufacturers may delay in investing in the development and production of new technologies, instead waiting for other manufacturers to bear the risks of those investments first. Competitive pressures in the HDV freight transport industry can provide a strong incentive to reduce fuel consumption and improve environmental performance. However, not every HDV operator has the requisite ability or interest to access and utilize the technical information, or the resources necessary to evaluate this information within the context of his or her own operations.

As discussed previously, whether the technologies available to improve HDVs' fuel efficiency would be adopted widely in the absence of the program is challenging to assess. To the extent that these technologies would be adopted in its absence, neither their costs nor their benefits would be attributed to the program. To account for this possibility, the agencies analyzed the proposed standards and the regulatory alternatives against two reference cases, or baselines, as described in Section X.

The first case uses a baseline that projects some improvement in fuel efficiency for new trailers, but no improvement in fuel efficiency for other vehicle segments in the absence of new Phase 2 standards. This first case is referred to as the less dynamic baseline, or Alternative 1a. The second case uses a baseline that projects some improvement in vehicle fuel efficiency for tractors, trailers, pickup trucks, and vans but not for vocational vehicles. This second case is referred to as the more dynamic baseline, or Alternative 1b.

The agencies will continue to explore reasons for the slow adoption of readily available and apparently cost-effective technologies for improving fuel efficiency. We also seek comments on our hypotheses about its causes, as well as data or other information that can inform our understanding of why this situation seems to persist.

B. Vehicle-Related Costs Associated With the Program

(1) Technology Cost Methodology

(a) Direct Manufacturing Costs

The direct manufacturing costs (DMCs) used throughout this analysis are derived from several sources. Many of the tractor, vocational and trailer DMCs can be sourced to the Phase 1 rule which, in turn, were sourced largely from a contracted study by ICF International for EPA.[633] We have updated those costs by converting them to 2012 dollars, as described in Section IX.B.1.e below, and by continuing the learning effects described in the Phase 1 rule and in Section IX.B.1.c below. The new tractor, vocational and trailer costs can be sourced to a more recent study conducted by Tetra Tech under contract to NHTSA.[634] The cost methodology used by Tetra Tech was to estimate retail costs and work backward from there to derive a DMC for each technology. The agencies did not agree with the approach used by Tetra Tech to move from retail cost to DMC as the approach was to simply divide retail costs by 2 and use the result as a DMC. Our research, discussed below, suggests that a divisor of 2 is too high. Therefore, where we have used a Tetra Tech derived retail estimate, we have divided by our researched markups to arrive at many of the DMCs used in this analysis. In this way, the agencies have used an approach consistent with past GHG/CAFE/fuel consumption rules by dividing estimated retail prices by our estimated retail price equivalent (RPE) markups to derive an appropriate DMC for each technology. We describe our RPEs in Section IX.B.1.b, below.

For HD pickups and vans, we have relied primarily on the Phase 1 rule and the recent light-duty 2017–2025 model year rule since most technologies expected on these vehicles are, in effect, the same as those used on light-duty pickups. Many of those technology DMCs are based on cost teardown studies which the agencies consider to be the most robust method of cost estimation. However, because most of the HD versions of those technologies are expected to be more costly than their light-duty counterparts, we have scaled upward most of the light-duty DMCs for this analysis. We have also used some costs developed under contract to NHTSA by Tetra Tech.[635]

Importantly, in our methodology, all technologies are treated as being sourced from a supplier rather than being developed and produced in-house. As a result, some portion of the total indirect costs of making a technology or system—those costs incurred by the supplier for research, development, transportation, marketing etc.—are contained in the sales price to the engine and/or vehicle/trailer manufacturer (*i.e.,* the original equipment manufacturer (OEM)). That

[631] American Transportation Research Institute, *An Analysis of the Operational Costs of Trucking,* September 2013 (Docket ID: EPA–HQ–OAR–2014–0827).

[632] Transport Canada, Operating Cost of Trucks, 2005. See *http://www.tc.gc.ca/eng/policy/report-acg-operatingcost2005-2005-e-2-1727.htm*, accessed on July 16, 2010 (Docket ID: EPA–HQ–OAR–2014–0827).

[633] ICF International. Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for Heavy-Duty On-Road Vehicles. July 2010.

[634] Schubert, R., Chan, M., Law, K. (2015). Commercial Medium- and Heavy-Duty (MD/HD) Truck Fuel Efficiency Cost Study. Washington, DC: National Highway Traffic Safety Administration.

[635] Schubert, R., Chan, M., Law, K. (2015). Commercial Medium- and Heavy-Duty (MD/HD) Truck Fuel Efficiency Cost Study. Washington, DC: National Highway Traffic Safety Administration.

sale price paid by the OEM to the supplier is the DMC we estimate.

We present the details—sources, DMC values, scaling from light-duty values, markups, learning effects, adoption rates—behind all our costs in Chapter 2 of the draft RIA.

(b) Indirect Costs

To produce a unit of output, engine and truck manufacturers incur direct and indirect costs. Direct costs include cost of materials and labor costs. Indirect costs are all the costs associated with producing the unit of output that are not direct costs—for example, they may be related to production (such as research and development [R&D]), corporate operations (such as salaries, pensions, and health care costs for corporate staff), or selling (such as transportation, dealer support, and marketing). Indirect costs are generally recovered by allocating a share of the costs to each unit of good sold. Although it is possible to account for direct costs allocated to each unit of good sold, it is more challenging to account for indirect costs allocated to a unit of goods sold. To make a cost analysis process more feasible, markup factors, which relate total indirect costs to total direct costs, have been developed. These factors are often referred to as retail price equivalent (RPE) multipliers.

While the agencies have traditionally used RPE multipliers to estimate indirect costs, in recent GHG/CAFE/fuel consumption rules RPEs have been replaced in the primary analysis with indirect cost multipliers (ICMs). ICMs differ from RPEs in that they attempt to estimate not all indirect costs incurred to bring a product to point of sale, but only those indirect costs that change as a result of a government action or regulatory requirement. As such, some indirect costs, notably health and retirement benefits of retired employees, among other indirect costs, would not be expected to change due to a government action and, therefore, the portion of the RPE that covered those costs does not change.

Further, the ICM is not a ''one-size-fits-all'' markup as is the traditional RPE. With ICMs, higher complexity technologies like hybridization or moving from a manual to automatic transmission may require higher indirect costs—more research and development, more integration work, etc.—suggesting a higher markup. Conversely, lower complexity technologies like reducing friction or adding passive aero features may require fewer indirect costs thereby suggesting a lower markup.

Notably, ICMs are also not a simple multiplier as are traditional RPEs. The ICM is broken into two parts—warranty related and non-warranty related costs. The warranty related portion of the ICM is relatively small while the non-warranty portion represents typically over 95 percent of indirect costs. These two portions are applied to different DMC values to arrive at total costs (TC). The warranty portion of the markup is applied to a DMC that decreases year-over-year due to learning effects (described below in Section IX.B.1.c).[636] As learning effects decrease the DMC with production volumes, it makes sense that warranty costs would decrease since those parts replaced under warranty should be less costly. In contrast, the non-warranty portion of the markup is applied to a static DMC year-over-year resulting in static indirect costs. This is logical since the production plants and transportation networks and general overhead required to build parts, market them, deliver them and integrate them into vehicles do not necessarily decrease in cost year-over-year. Because the warranty and non-warranty portions of the ICM are applied differently, one cannot compare the markup itself to the RPE to determine which markup would result in higher indirect cost estimates, at least in the time periods typically considered in our rules (four to ten years).

The agencies are concerned that some potential costs associated with this rulemaking may not be adequately captured by our ICMs. ICMs are estimated based on a few specific technologies and these technologies may not be representative of the changes actually made to meet the proposed requirements. Specifically, we may not have adequately estimated the costs for accelerated R&D or potential reliability issues with advanced technologies required by Alternative 4. There is a great deal of uncertainty regarding these costs, and this makes estimates for this alternative of particular concern. We request comment on that aspect of our estimates and on all aspects of our indirect cost estimation approach.

We provide more details on our ICM approach and the markups used for each technology in Chapter 2.12 of the draft RIA.

[636] We note that the labor portion of warranty repairs does not decrease due to learning. However, we do not have data to separate this portion and so we apply learning to the entire warranty cost. Because warranty costs are a small portion of overall indirect costs, this has only a minor impact on the analysis.

(c) Learning Effects on Direct and Indirect Costs

For some of the technologies considered in this analysis, manufacturer learning effects would be expected to play a role in the actual end costs. The ''learning curve'' or ''experience curve'' describes the reduction in unit production costs as a function of accumulated production volume. In theory, the cost behavior it describes applies to cumulative production volume measured at the level of an individual manufacturer, although it is often assumed—as both agencies have done in past regulatory analyses—to apply at the industry-wide level, particularly in industries that utilize many common technologies and component supply sources. Both agencies believe there are indeed many factors that cause costs to decrease over time. Research in the costs of manufacturing has consistently shown that, as manufacturers gain experience in production, they are able to apply innovations to simplify machining and assembly operations, use lower cost materials, and reduce the number or complexity of component parts. All of these factors allow manufacturers to lower the per-unit cost of production (*i.e.,* the manufacturing learning curve).[637]

In this analysis, the agencies are using the same approach to learning as done in past GHG/CAFE/fuel consumption rules. In short, learning effects result in rapid cost reductions in the early years following introduction of a new technology. The agencies have estimated those cost reductions as resulting in 20 percent lower costs for every doubling of production volume. As production volumes increase, learning rates continue at the same pace but flatten asymptotically due to the nature of the persistent doubling of production required to realize that cost reduction. As such, the cost reductions flatten out as production volumes continue to increase. Consistent with the Phase 1 rule, we refer to these two distinct portions of the ''learning cost reduction curve'' or ''learning curve'' as the steeper and flatter portions of the curve. On that steep portion of the curve, costs are estimated to decrease by

[637] See ''Learning Curves in Manufacturing'', L. Argote and D. Epple, Science, Volume 247; ''Toward Cost Buy down Via Learning-by-Doing for Environmental Energy Technologies, R. Williams, Princeton University, Workshop on Learning-by-Doing in Energy Technologies, June 2003; ''Industry Learning Environmental and the Heterogeneity of Firm Performance, N. Balasubramanian and M. Lieberman, UCLA Anderson School of Management, December 2006, Discussion Papers, Center for Economic Studies, Washington DC.

20 percent for each double of production or, by proxy, in the third and then fifth year of production following introduction. On the flat portion of the curve, costs are estimated to decrease by 3 percent per year for 5 years, then 2 percent per year for 5 years, then 1 percent per year for 5 years. Also consistent with the Phase 1 rule, the majority of the technologies we expect would be adopted are considered to be on the flat portion of the learning curve meaning that the 20 percent cost reductions are rarely applied. The agencies request comment on this approach to estimating these effects, and request that commenters provide data and forward-looking information to support any alternative methods or specific estimates.

We provide more details on the concept of learning-by-doing and the learning effects applied in this analysis in Chapter 2 of the draft RIA.

(d) Technology Adoption Rates and Developing Package Costs

Determining the stringency of the proposed standards involves a balancing of relevant factors—chiefly technology feasibility and effectiveness, costs, and lead time. For vocational vehicles, tractors and trailers, the agencies have projected a technology path to achieve the proposed standards reflecting an application rate of those technologies the agencies consider to be available at reasonable cost in the lead times provided. The agencies do not expect each of the technologies for which costs have been developed to be employed by all trucks and trailers across the board. Further, many of today's vehicles are already equipped with some of the technologies and/or are expected to adopt them by MY2018 to comply with the HD Phase 1 standards. Estimated adoption rates in both the reference and control cases are necessary for each vehicle/trailer category. The adoption rates for most technologies are zero in the reference case; however, for some technologies—notably aero and tire technologies—the adoption rate is not zero in the reference case. These reference and control case adoption rates are then applied to the technology costs with the result being a package cost for each vehicle/trailer category.

For HD pickups and vans, the CAFE model determines the technology adoption rates that most cost effectively meet the standards being proposed. Similar to vocational vehicles, tractors and trailers, package costs are rarely if ever a simple sum of all the technology costs since each technology would be expected to be adopted at different rates. The methods for estimating technology adoption rates and resultant costs (and other impacts) for HD pickups and vans are discussed above in Section 6.

We provide details of expected adoption rates in Chapter 2 of the draft RIA. We present package costs both in Sections III through VI of this preamble and in more detail in Chapter 2 of the draft RIA.

(e) Conversion of Technology Costs to 2012 U.S. Dollars

As noted above in Section IX.B.1, the agencies are using technology costs from many different sources. These sources, having been published in different years, present costs in different year dollars (*i.e.,* 2009 dollars or 2010 dollars). For this analysis, the agencies sought to have all costs in terms of 2012 dollars to be consistent with the dollars used by AEO in its 2014 Annual Energy Outlook.[638] The agencies have used the GDP Implicit Price Deflator for Gross Domestic Product as the converter, with the actual factors used as shown in Table IX–1.[639]

TABLE IX–1—IMPLICIT PRICE DEFLATORS AND CONVERSION FACTORS FOR CONVERSION TO 2012$

	2006	2007	2008	2009	2010	2011	2012	2013
Price index for GDP	94.818	97.335	99.236	100	101.211	103.199	105.002	106.588
Factor applied for 2012$	1.107	1.079	1.058	1.050	1.037	1.017	1.000	0.985

(2) Compliance Program Costs

The agencies have also estimated additional and/or new compliance costs associated with the proposed standards. Normally, compliance program costs would be considered part of the indirect costs and, therefore, would be accounted for via the markup applied to direct manufacturing costs. However, since the agencies are proposing new compliance elements that were not present during development of the indirect cost markups used in this analysis, additional compliance program costs are being accounted for via a separate ''line-item.'' New research and development costs (see below) are being handled in the same way.

The new compliance program elements included in this proposal are new powertrain testing within the vocational vehicle program, and an all-new compliance program where none has existed to date within the trailer program. Note that for HD pickups and vans, HD engines, vocational vehicles and tractors, the Phase 1 rule included analogous compliance program costs meant to account for costs incurred in the all-new compliance program placed on the regulated firms by that rule. Compliance program costs cover costs associated with any necessary compliance testing and reporting to the agencies and differ somewhat by alternative since, for example, more manufacturers are expected to conduct powertrain testing under alternative 4 than under alternative 3, etc. The details behind the estimated compliance program costs are provided in Chapter 7 of the draft RIA. We request comment on our estimated compliance costs.

(3) Research and Development Costs

Much like the compliance program costs described above, we have estimated additional HDD engine, vocational vehicle and tractor R&D associated with the proposed standards that is not accounted for via the indirect cost markups used for these segments. Much like the Phase 1 rule, EPA is estimating these additional R&D costs will occur over a 4-year timeframe as the proposed standards come into force and industry works on means to comply. After that period, the additional R&D costs go to $0 as R&D expenditures return to their normal levels and R&D costs are accounted for via the ICMs—and the RPEs behind them—used for these segments. Note that, due to the accelerated implementation of some technologies, alternative 4 has higher R&D costs than does alternative 3. The details behind the estimated R&D costs are provided in Chapter 7 of the draft RIA. We request comment on our estimated R&D costs.

[638] U.S. Energy Information Administration, Annual Energy Outlook 2014, Early Release; Report Number DOE/EIA–0383ER (2014), December 16, 2013.

[639] Bureau of Economic Analysis, Table 1.1.9 Implicit Price Deflators for Gross Domestic Product; as revised on March 27, 2014.

(4) Summary of Costs of the Proposed Vehicle Programs

The agencies have estimated the costs of the proposed vehicle standards on an annual basis for the years 2018 through 2050, and have also estimated costs for the full model year lifetimes of MY2018 through MY2029 vehicles. Table IX–2 shows the annual costs of the proposed standards along with net present values using both 3 percent and 7 percent discount rates. Table IX–3 shows the discounted model year lifetime costs of the proposed standards at both 3 percent and 7 percent discount rates along with sums across applicable model years.

TABLE IX–2—ANNUAL COSTS OF THE PREFERRED ALTERNATIVE AND NET PRESENT VALUES AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[$Millions of 2012$] [a]

Calendar year	New technology	Compliance	R&D	Sum
2018	116	0	0	116
2019	113	0	0	113
2020	112	0	0	112
2021	2,173	18	240	2,432
2022	2,161	6	240	2,407
2023	2,224	6	240	2,470
2024	3,455	6	240	3,701
2025	3,647	6	0	3,653
2026	3,736	6	0	3,742
2027	5,309	6	0	5,315
2028	5,334	6	0	5,340
2029	5,376	6	0	5,381
2030	5,399	6	0	5,405
2035	5,856	6	0	5,862
2040	6,316	6	0	6,322
2050	6,987	6	0	6,992
NPV, 3%	85,926	104	759	86,789
NPV, 7%	40,516	56	561	41,133

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE IX–3—DISCOUNTED MY LIFETIME COSTS OF THE PREFERRED ALTERNATIVE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[$Millions of 2012$] [a]

Model year	Discounted at 3%				Discounted at 7%			
	New technology	Compliance	R&D	Sum	New technology	Compliance	R&D	Sum
2018	104	0	0	104	91	0	0	91
2019	99	0	0	99	84	0	0	84
2020	95	0	0	95	77	0	0	77
2021	1,794	15	198	2,007	1,401	12	155	1,567
2022	1,731	5	193	1,928	1,302	3	145	1,450
2023	1,730	4	187	1,921	1,252	3	135	1,390
2024	2,610	4	181	2,795	1,818	3	126	1,947
2025	2,674	4	0	2,678	1,793	3	0	1,796
2026	2,660	4	0	2,664	1,717	3	0	1,719
2027	3,670	4	0	3,673	2,280	2	0	2,283
2028	3,580	4	0	3,583	2,141	2	0	2,143
2029	3,502	4	0	3,506	2,017	2	0	2,019
Sum	24,248	48	759	25,055	15,973	33	561	16,568

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

New technology costs begin in MY2018 as trailers begin to add new technology. Compliance costs begin with the new standards with capital cost expenditure in that year for building and upgrading test facilities to conduct the proposed powertrain testing in the vocational program. Research and development costs begin in 2021 and last for 4 years as engine, tractor and vocational vehicle manufacturers conduct research and development testing to integrate new technologies into their engines and vehicles. We request comment on all aspects of our technology costs, both individual technology costs and package costs, as detailed in Chapter 2 of the draft RIA.

C. Changes in Fuel Consumption and Expenditures

(1) Changes in Fuel Consumption

The new GHG and fuel consumption standards would result in significant improvements in the fuel efficiency of affected vehicles, and drivers of those vehicles would see corresponding savings associated with reduced fuel expenditures. The agencies have estimated the impacts on fuel consumption for the proposed standards. Details behind how these changes in fuel consumption were calculated are presented in Section VII of this preamble and in Chapter 5 of the draft RIA. The total number of miles that vehicles are driven each year is different under the regulatory alternatives than in the reference case due to the ''rebound effect'' (discussed below in Section IX.E), so the changes in fuel consumption associated with each alternative are not strictly proportional to differences in the fuel economy levels they require.

The expected annual impacts on fuel consumption are shown in Table IX–4. Table IX–5 shows the MY lifetime changes in fuel consumption. The gallons shown in these tables as reductions in fuel consumption reflect reductions due to the proposed standards and include any increased consumption resulting from the rebound effect (discussed below in Section IX.E).

TABLE IX–4—ANNUAL FUEL CONSUMPTION REDUCTIONS DUE TO THE PREFERRED ALTERNATIVE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of gallons] [a]

Calendar year	Gasoline			Diesel		
	Reference case	Fuel consumption reduction	% Reduction	Reference case	Fuel consumption reduction	% Reduction
2018	6,781	0	0	45,999	74	0
2019	6,799	0	0	46,362	150	0
2020	6,832	0	0	46,768	227	0
2021	6,884	10	0	47,236	523	1
2022	6,944	29	0	47,761	894	2
2023	7,005	57	1	48,309	1,276	3
2024	7,054	99	1	48,807	1,895	4
2025	7,113	151	2	49,400	2,523	5
2026	7,169	210	3	49,967	3,152	6
2027	7,221	291	4	50,420	3,890	8
2028	7,273	369	5	50,821	4,600	9
2029	7,332	445	6	51,262	5,278	10
2030	7,396	516	7	51,792	5,924	11
2035	7,732	801	10	54,602	8,517	16
2040	8,075	968	12	58,082	10,209	18
2050	8,806	1,127	13	65,937	12,310	19

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE IX–5—MODEL YEAR LIFETIME FUEL CONSUMPTION REDUCTIONS DUE TO THE PREFERRED ALTERNATIVE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of Gallons] [a]

Model year	Gasoline			Diesel		
	Reference	Fuel consumption reduction	% Reduction	Reference	Fuel consumption reduction	% Reduction
2018	0	0	0	33,384	754	2
2019	0	0	0	33,922	745	2
2020	0	0	0	34,575	738	2
2021	7,128	113	2	47,792	4,424	9
2022	7,118	216	3	48,112	4,568	9
2023	7,106	317	4	48,366	4,703	10
2024	7,225	493	7	49,577	7,628	15
2025	7,376	602	8	51,050	7,967	16
2026	7,535	714	9	52,420	8,289	16
2027	7,628	982	13	53,532	9,984	19
2028	7,711	992	13	54,524	10,181	19
2029	7,769	999	13	55,421	10,360	19

TABLE IX–5—MODEL YEAR LIFETIME FUEL CONSUMPTION REDUCTIONS DUE TO THE PREFERRED ALTERNATIVE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE—Continued

[Millions of Gallons] [a]

Model year	Gasoline			Diesel		
	Reference	Fuel consumption reduction	% Reduction	Reference	Fuel consumption reduction	% Reduction
Sum	66,596	5,430	8	562,673	70,342	13

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(2) Fuel Savings

We have also estimated the changes in fuel expenditures, or the fuel savings, using fuel prices estimated in the Energy and Information Administration's 2014 Annual Energy Outlook.[640] As the AEO fuel price projections go through 2040 and not beyond, fuel prices beyond 2040 were set equal to the 2040 values. These estimates do not account for the significant uncertainty in future fuel prices; the monetized fuel savings would be understated if actual fuel prices are higher (or overstated if fuel prices are lower) than estimated. The Annual Energy Outlook (AEO) is a standard reference used by NHTSA and EPA and many other government agencies to estimate the projected price of fuel. This has been done using both the pre-tax and post-tax fuel prices. Since the post-tax fuel prices are the prices paid at fuel pumps, the fuel savings calculated using these prices represent the changes fuel purchasers would see. The pre-tax fuel savings measure the value to society of the resources saved when less fuel is refined and consumed. Assuming no change in fuel tax rates, the difference between these two columns represents the reduction in fuel tax revenues that would be received by state and federal governments, or about $240 million in 2021 and $5.2 billion by 2050 as shown in Table IX–6 where annual changes in monetized fuel savings are shown along with net present values using 3 percent and 7 percent discount rates. Table IX–7 Table IX–8 show the discounted model year lifetime fuel savings using 3 percent and 7 percent discount rates, respectively.

TABLE IX–6—ANNUAL FUEL SAVINGS AND NET PRESENT VALUES AT 3% AND 7% DISCOUNT RATES USING METHOD B FOR THE PREFERRED ALTERNATIVE AND RELATIVE TO THE LESS DYNAMIC BASELINE

[$Millions of 2012$] [a]

Calendar year	Fuel savings—retail			Fuel savings—untaxed			Change in transfer
	Gasoline	Diesel	Sum	Gasoline	Diesel	Sum	
2018	$0	$261	$261	$0	$227	$227	$34
2019	0	540	540	0	472	472	68
2020	0	834	834	0	731	731	103
2021	31	1,958	1,989	27	1,723	1,750	239
2022	92	3,413	3,505	80	3,015	3,095	410
2023	183	4,936	5,119	160	4,372	4,532	587
2024	324	7,426	7,750	285	6,594	6,879	871
2025	496	10,035	10,531	436	8,937	9,372	1,158
2026	695	12,683	13,378	613	11,321	11,934	1,445
2027	976	15,883	16,859	861	14,215	15,076	1,782
2028	1,243	18,938	20,181	1,099	16,980	18,079	2,102
2029	1,511	21,974	23,485	1,338	19,745	21,083	2,402
2030	1,770	24,905	26,675	1,571	22,422	23,993	2,682
2035	2,921	38,047	40,968	2,621	34,621	37,242	3,726
2040	3,778	48,300	52,078	3,427	44,357	47,783	4,295
2050	4,397	58,241	62,638	3,988	53,486	57,474	5,164
NPV, 3%	37,319	506,971	544,290	33,603	461,992	495,595	48,695
NPR, 7%	15,211	212,373	227,584	13,663	192,984	206,646	20,937

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[640] U.S. Energy Information Administration, Annual Energy Outlook 2014, Early Release; Report Number DOE/EIA–0383ER (2014), December 16, 2013.

TABLE IX–7—DISCOUNTED MODEL YEAR LIFETIME FUEL SAVINGS, 3% DISCOUNT RATE USING METHOD B FOR THE PREFERRED ALTERNATIVE AND RELATIVE TO THE LESS DYNAMIC BASELINE

[$Millions of 2012$] [a]

Model year	Fuel savings—retail			Fuel savings—untaxed			Change in transfer
	Gasoline	Diesel	Sum	Gasoline	Diesel	Sum	
2018	$0	$2,183	$2,183	$0	$1,937	$1,937	$246
2019	0	2,123	2,123	0	1,890	1,890	234
2020	0	2,066	2,066	0	1,844	1,844	222
2021	258	12,178	12,436	228	10,898	11,126	1,310
2022	487	12,369	12,856	431	11,094	11,525	1,331
2023	700	12,513	13,212	620	11,247	11,867	1,346
2024	1,067	19,934	21,001	947	17,953	18,901	2,100
2025	1,277	20,435	21,712	1,136	18,441	19,577	2,135
2026	1,484	20,858	22,342	1,323	18,858	20,180	2,161
2027	2,001	24,642	26,643	1,787	22,319	24,106	2,537
2028	1,981	24,610	26,592	1,772	22,329	24,101	2,491
2029	1,957	24,536	26,493	1,754	22,298	24,052	2,441
Sum	11,211	178,448	189,659	9,997	161,107	171,105	18,554

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE IX–8—DISCOUNTED MODEL YEAR LIFETIME FUEL SAVINGS, 7% DISCOUNT RATE USING METHOD B FOR THE PREFERRED ALTERNATIVE AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of 2012] [a]

Model year	Fuel savings—retail			Fuel savings—untaxed			Change in transfer
	Gasoline	Diesel	Sum	Gasoline	Diesel	Sum	
2018	$0	$1,529	$1,529	$0	$1,352	$1,352	$176
2019	0	1,428	1,428	0	1,267	1,267	161
2020	0	1,331	1,331	0	1,185	1,185	146
2021	163	7,538	7,701	143	6,731	6,874	827
2022	295	7,383	7,678	260	6,608	6,869	810
2023	408	7,200	7,607	361	6,458	6,819	789
2024	599	11,055	11,654	531	9,938	10,469	1,186
2025	690	10,917	11,607	613	9,834	10,447	1,160
2026	772	10,734	11,505	687	9,688	10,374	1,131
2027	1,003	12,215	13,218	894	11,046	11,940	1,278
2028	956	11,741	12,697	854	10,636	11,490	1,206
2029	909	11,269	12,179	814	10,228	11,041	1,137
Sum	5,794	94,339	100,134	5,157	84,971	90,128	10,005

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

D. Maintenance Expenditures

The agencies expect minimal increases in maintenance costs under the proposed standards, having estimated increased maintenance costs associated only with installation of lower rolling resistance tires. We expect that, when replaced, the lower rolling resistance tires would be replaced by equivalent performing tires throughout the vehicle lifetime. As such, the incremental increases in costs for lower rolling resistance tires would be incurred throughout the vehicle lifetime at intervals consistent with current tire replacement intervals. Those intervals are difficult to quantify given the variety of vehicles and operating modes within the HD industry. We detail the inputs used to estimate maintenance impacts in Chapter 7.3.3 of the draft RIA. We request comment on all aspects of the maintenance estimates. Specifically, for electrified vehicles (mild/strong hybrids) which are expected in alternatives 3 and 4 and in each vehicle category, we have not estimated any increased maintenance costs. We have heard from at least one source [641] that strong hybrid maintenance can be higher in some ways, including possible battery replacement, but may also be much lower for some vehicle systems like brakes and general engine wear. Given the uncertainty, we have not estimated maintenance costs specifically for these electrified vehicles but request comment so that we might be able to include potential costs in the final rule. We also request comment on any other maintenance costs that should be considered along with supporting data.

Table IX–9 shows the annual increased maintenance costs of the preferred alternative along with net present values using both 3 percent and 7 percent discount rates. Table IX–10 shows the discounted model year lifetime increased maintenance costs of the preferred alternative at both 3 percent and 7 percent discount rates along with sums across applicable model years.

[641] Allison Transmission's Responses to EPA's Hybrid Questions, November 6, 2014.

TABLE IX–9—ANNUAL MAINTENANCE EXPENDITURE INCREASE DUE TO THE PROPOSAL AND NET PRESENT VALUES AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[$Millions of 2012$] [a]

Calendar year	Maintenance expenditure increase
2018	$6
2019	11
2020	16
2021	28
2022	39
2023	50
2024	64
2025	78
2026	90
2027	104
2028	116
2029	127
2030	127
2035	127
2040	127
2050	127
NPV, 3%	1,796
NPV, 7%	860

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE IX–10—DISCOUNTED MY LIFETIME MAINTENANCE EXPENDITURE INCREASE DUE TO THE PROPOSAL USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[$Millions of 2012$] [a]

Model year	3% Discount rate	7% Discount rate
2018	51	36
2019	49	33
2020	47	31
2021	90	57
2022	89	54
2023	89	52
2024	112	63
2025	113	61
2026	102	53
2027	116	58
2028	111	54
2029	101	47
Sum	1,071	600

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

E. Analysis of the Rebound Effect

The ''rebound effect'' has been defined a number of ways in the literature, and one common definition states that the rebound effect is the increase in demand for an energy service when the cost of the energy service is reduced due to efficiency improvements.[642] [643] [644] In the context of heavy-duty vehicles (HDVs), this can be interpreted as an increase in HDV fuel consumption resulting from more intensive vehicle use in response to increased vehicle fuel efficiency.[645] Although much of this vehicle use increase is likely to take the form of increases in the number of miles vehicles are driven, it can also take the form of increases in the loaded weight at which vehicles operate or changes in traffic and road conditions vehicles encounter as operators alter their routes and schedules in response to improved fuel efficiency. Because this more intensive use consumes fuel and generates emissions, it reduces the fuel savings and avoided emissions that would otherwise be expected to result from the increases in fuel efficiency this rulemaking proposes.

Unlike the light-duty vehicle (LDV) rebound effect, the HDV rebound effect has not been extensively studied. According to a 2010 HDV report published by the National Research Council of the National Academies (NRC),[646] it is ''not possible to provide

[642] Winebrake, J.J., Green, E.H., Comer, B., Corbett, J.J., Froman, S., 2012. Estimating the direct rebound effect for on-road freight transportation. Energy Policy 48, 252–259.

[643] Greene, D.L., Kahn, J.R., Gibson, R.C., 1999, ''Fuel economy rebound effect for U.S. household vehicles'', The Energy Journal, 20.

[644] For a discussion of the wide range of definitions found in the literature, see Appendix D: Discrepancy in Rebound Effect Definitions, in EERA (2014), ''Research to Inform Analysis of the Heavy-Duty vehicle Rebound Effect'', Excerpts of Draft Final Report of Phase 1 under EPA contract EP–C–13–025. (Docket ID: EPA–HQ–OAR–2014–0827). See also Greening, L.A., Greene, D.L., Difiglio, C., 2000, ''Energy efficiency and consumption—the rebound effect—a survey'', Energy Policy, 28, 389–401.

[645] We discuss other potential rebound effects in section IX.D.3, such as the indirect and economy-wide rebound effects. Note also that there is more than one way to measure HDV energy services and vehicle use. The agencies' analyses use VMT as a measure (as discussed below); other potential measures include ton-miles, cube-miles, and fuel consumption.

[646] Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles; National Research Council; Transportation Research Board (2010). ''Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,'' Washington, DC. The National Academies Press. Available electronically from the

a confident measure of the rebound effect,'' yet NRC concluded that a HDV rebound effect probably exists and that, ''estimates of fuel savings from regulatory standards will be somewhat misestimated if the rebound effect is not considered.'' Although we believe the HDV rebound effect needs to be studied in more detail, we have nevertheless attempted to capture its potential effect in our analysis of these proposed rules, rather than to await further study. We have elected to do so because the magnitude of the rebound effect is an important determinant of the actual fuel savings and emission reductions that are likely to result from adopting stricter fuel efficiency and GHG emission standards.

In our analysis and discussion below, we focus on one widely-used metric to estimate the rebound effect associated with all types of more intensive vehicle use, the increase in vehicle miles traveled (VMT) that results from improved fuel efficiency. VMT can often provide a reasonable approximation for all types of more intensive vehicle use. For simplicity, we refer to this as ''the VMT rebound effect'' or ''VMT rebound'' throughout this section, although we acknowledge that it is an approximation to the rebound effect associated with all types of more intensive vehicle use. The agencies use our VMT rebound estimates to generate VMT inputs that are then entered into the EPA MOVES national emissions inventory model and the Volpe Center's HD CAFE model. Both of these models use these inputs along with many others to generate projected emissions and fuel consumption changes resulting from each of the regulatory alternatives analyzed.

Using VMT rebound to approximate the fuel consumption impact from all types of more intensive vehicle use may not be completely accurate. Many factors other than distance traveled—for example, a vehicle's loaded weight—play a role in determining its fuel consumption, so it is also important to consider how changes in these factors are correlated with variation in vehicle miles traveled. Empirical estimates of the effect of weight on HDV fuel consumption vary, but universally show that loaded weight has some effect on fuel consumption that is independent of distance traveled. Therefore, the product of vehicle payload and miles traveled, which typically is expressed in units of ''ton-miles'' or ''ton-kilometers'', has also been considered as a metric to approximate the rebound effect. Because this metric's value depends on both payload and distance, it is important to note that changes in these two variables can have different impacts on HDV fuel consumption. This is because the fuel consumed by HDV freight transport is determined by several vehicle attributes including engine and accessory efficiencies, aerodynamic characteristics, tire rolling resistance and total vehicle mass—including payload carried, if any.

Other factors such as vehicle route and traffic patterns can also affect how each of these vehicle attributes contributes to the overall fuel consumption of a vehicle. While it seems intuitive that if all of these other conditions remain constant, a vehicle driving the same route and distance twice will consume twice as much fuel as driving that same route once. However, because of the other vehicle attributes, it is less intuitive how a change in vehicle payload would affect vehicle fuel consumption. We request comment on how the agencies should consider the relationship between changes in vehicle miles traveled, changes in vehicle ton-miles achieved, and overall fuel consumption when considering how best to measure the rebound effect.

Because the factors influencing HDV VMT rebound are generally different from those affecting LDV VMT rebound, much of the research on the LDV sector is likely to not apply to the HDV sector. For example, the owners and operators of LDVs may respond to the costs and benefits associated with changes in their personal vehicle's fuel efficiency very differently than a HDV fleet owner or operator would view the costs and benefits (*e.g.,* profits, offering more competitive prices for services) associated with changes in their HDVs' fuel efficiency. To the extent the response differs, such differences may be smaller for HD pickups and vans, which share some similarities with LDVs. As discussed in the 2010 NRC HD report, one difference from the LDV case is that when calculating the change in HDV costs that causes the rebound effect, it is more important to consider all components of HDV operating costs. The costs of labor and fuel generally constitute the two largest shares of HDV operating costs, depending on the price of petroleum, distance traveled, type of vehicle, and commodity transported (if any).[647] [648] Equipment depreciation costs associated with the purchase or lease of an HDV are another significant component of total operating costs. Even when HDV purchases involve upfront, one-time payments, HDV operators must recover the depreciation in the value of their vehicles resulting from their use, so this is likely to be considered as an operating cost they will attempt to pass on to final consumers of HDV operator services.

Estimates of the impact of fuel efficiency standards on HDV VMT, and hence fuel consumption, should account for changes in all of these components of HDV operating costs. The higher the net savings in total operating costs is, the higher the expected rebound effect would be. Conversely, if higher HDV purchase costs outweigh future cost savings and total operating costs increase, HDV costs could rise, which would likely result in a decrease in HDV VMT. In theory, other cost changes resulting from any requirement to achieve higher fuel efficiency, such as changes in maintenance costs or insurance rates, should also be taken into account, although information on these elements of HDV operating costs is extremely limited. In this analysis, the agencies adapt estimates of the VMT rebound effect to project the response of HDV use to the estimated changes in total operating costs that result from the proposed Phase 2 standards. We seek comment and data on how our proposed standards could impact these and other types of HDV operating costs, as well as on our procedure for adapting the VMT rebound effect to estimate the response of HDV use to changes in total operating costs.

Since businesses are profit-driven, one would expect their decisions to be based on the costs and benefits of different operating decisions, both in the near-term and long-term. Specifically, one would expect commercial HDV operators to take into account changes in overall operating costs per mile when making decisions about HDV use and setting rates they charge for their services. If demand for those services is sensitive to the rates HDV operators charge, HDV VMT could change in response to the effect of higher fuel efficiency on the rates HDV operators charge. If demand for HDV services is insensitive to price (*e.g.,* due to lack of good substitutes), however, or if changes in HDV operating costs due to the proposed standards are not

National Academies Press Web site at *http://www.nap.edu/catalog.php?record_id=12845* (last accessed September 10, 2010).

[647] American Transportation Research Institute, *An Analysis of the Operational Costs of Trucking,* September 2013.

[648] Transport Canada, Operating Cost of Trucks, 2005. See *http://www.tc.gc.ca/eng/policy/report-acg-operatingcost2005-2005-e-2-1727.htm*, accessed on July 16, 2010.

passed on to final consumers of HDV operator services, the proposed standards may have a limited impact on HDV VMT.

The following sections describe the factors affecting the magnitude of HDV VMT rebound; review the econometric and other evidence related to HDV VMT rebound; and summarize how we estimated the HDV rebound effect for this proposal.

(1) Factors Affecting the Magnitude of HDV VMT Rebound

The magnitude and timing of HDV VMT rebound result from the interaction of many different factors.[649] Fuel savings resulting from fuel efficiency standards may cause HDV operators and their customers to change their patterns of HDV use and fuel consumption in a variety of ways. For example, HDV operators may pass on the fuel cost savings to their customers by decreasing prices for shipping products or providing services, which in turn could stimulate more demand for those products and services (*e.g.,* increases in freight output), and result in higher VMT. As discussed later in this section, HDV VMT rebound estimates determined via other proxy elasticities vary widely, but in no case has there been an estimate that fully offsets the fuel saved due to efficiency improvements (*i.e.,* no rebound effect greater than or equal to 100 percent).

If fuel cost savings are passed on to the HDV operators' customers (*e.g.,* logistics businesses, manufacturers, retailers, municipalities, utilities consumers), those customers might reorganize their logistics and distribution networks over time to take advantage of lower operating costs. For example, customers might order more frequent shipments or choose products that entail longer shipping distances, while freight carriers might divert some shipments to trucks from other shipping modes such as rail, barge or air. In addition, customers might choose to reduce their number of warehouses, reduce shipment rates or make smaller but more frequent shipments, all of which could lead to an increase in HDV VMT. Ultimately, fuel cost savings could ripple through the entire economy, thus increasing demand for goods and services shipped by trucks, and therefore increase HDV VMT due to increased gross domestic product (GDP).

Conversely, if fuel efficiency standards lead to net increases in the total costs of HDV operation because fuel cost savings do not fully offset the increase in HDV purchase prices and associated depreciation costs, then the price of HDV services could rise. This is likely to spur a decrease in HDV VMT, and perhaps a shift to alternative shipping modes. These effects could also ripple through the economy and affect GDP. Note, however, that we project fuel cost savings will offset technology costs in our analysis supporting our proposed standards.

It is also important to note that any increase in HDV VMT resulting from our proposed standards may be offset, to some extent, by a decrease in VMT by older HDVs. This may occur if lower fuel costs resulting from our standards cause multi-vehicle fleet operators to shift VMT to newer, more efficient HDVs in their fleet or cause operators with newer, more efficient HDVs to be more successful at winning contracts than operators with older HDVs.

Also, as discussed in Chapter 8.3.3 of the Draft RIA, the magnitude of the rebound effect is likely to be influenced by the extent of any market failures that affect the demand for more fuel efficient HDVs, as well as by HDV operators' responses to their perception of the tradeoff between higher upfront HDV purchase costs versus lower but uncertain future expenditures on fuel.

(2) Econometric and Other Evidence Related to HDV VMT Rebound

As discussed above, HDV VMT rebound is defined as the change in HDV VMT that occurs in response to an increase in HDV fuel efficiency. We are not aware of any studies that directly estimate this elasticity[650] for the U.S. This section discusses econometric analyses of other related elasticities that could potentially be used as a proxy for measuring HDV VMT rebound, as well as other analyses that may provide insight into the magnitude of HDV VMT rebound. We seek comment on the applicability of the findings from these analyses, as well as additional data and research on the topic of HDV VMT rebound.

One of the challenges to developing robust econometric analyses of HDV VMT rebound in the U.S. is data limitations. For example, the main source of time-series HDV fuel efficiency data in the U.S. is derived from aggregate fuel consumption and HDV VMT data. This may introduce interdependence or ''simultaneity'' between measures of HDV VMT and HDV fuel efficiency, because estimates of HDV fuel efficiency are derived partly from HDV VMT. This mutual interdependence makes it difficult to isolate the causal effect of HDV fuel efficiency on HDV VMT and to measure the response of HDV VMT to changes in HDV fuel efficiency.

Data on other important determinants of HDV VMT, such as freight shipping rates, shipment sizes, HDV payloads, and congestion levels on key HDV routes is also limited, of questionable reliability, or unavailable. Additionally, data on HDVs and their use is usually only available at an aggregate level, making it difficult to evaluate potential differences in determinants of VMT for different types of HDV operations (*e.g.,* long-haul freight vs. regional delivery operations) or vehicle sub-classes (*e.g.,* utility vehicles vs. school buses).

Another challenge inherent in using econometric techniques to measure the response of HDV VMT to HDV fuel efficiency is developing model specifications that incorporate the mathematical form and range of explanatory variables necessary to produce reliable estimates of HDV VMT rebound. Many different factors can influence HDV VMT, and the complex relationships among those factors should be considered when measuring the rebound effect.[651]

In practice, however, most studies have employed simplified models. Many use price variables (*e.g.,* price per gallon of fuel, or fuel cost per mile driven) and some measure of aggregate economic activity, such as GDP. However, some of these studies exclude potentially important variables such as the amount of road capacity (which affects travel speeds and may be related to other important characteristics of highway infrastructure), or the price or availability of competing forms of freight transport such as rail or barge (*i.e.,* characteristics of the overall freight transport network).

[649] These factors are discussed more fully in a report to EPA from EERA, which illustrates in a series of diagrams the complex system of decisions and decision-makers that could influence the magnitude and timing of the rebound effect. See Sections 2.2.2, 2.2.3, 2.2.4, and 2.3 in EERA (2014), ''Research to Inform Analysis of the Heavy-Duty Vehicle Rebound Effect'', Excerpts of Draft Final Report of Phase 1 under EPA contract EP–C–13–025.

[650] Elasticity is the measurement of how responsive an economic variable is to a change in another. For example: *price elasticity of demand* is a measure used in economics to show the responsiveness, or elasticity, of the quantity demanded of a good or service to a change in its price. More precisely, it gives the percentage change in quantity demanded in response to a one percent change in price.

[651] A useful framework for understanding how various responses interact to determine the rebound effect is presented in Section 2 and Appendix B of De Borger, B. and Mulalic, I. (2012), ''The determinants of fuel use in the trucking industry—volume, fleet characteristics and the rebound effect'', Transportation Policy, Volume 24, pp. 284–295. See also Section 3.4 of EERA (2014), ''Research to Inform Analysis of the Heavy-Duty vehicle Rebound Effect'', Excerpts of Draft Final Report of Phase 1 under EPA contract EP–C–13–025.

(a) Fuel Price and Fuel Cost Elasticities

This sub-section reviews econometric analyses of the change in HDV use (measured in VMT, ton-mile, or fuel consumption) in response to changes in fuel price ($/gallon) or fuel cost ($/mile or $/ton-mile). The studies presented below attempt to estimate these elasticities in the HDV sector using varying approaches and data sources.

Gately (1990) employed an econometric analysis of U.S. data for the years 1966–1988 to examine the relationship between HDV VMT and average fuel cost per mile, real Gross National Product (GNP), and variables capturing the effects of fuel shortages in 1974 and 1979.[652] The study found no statistically significant relationship between HDV VMT and fuel cost per mile. Gately's estimates of the elasticity of HDV VMT with respect to fuel cost per mile were −0.035 with and −0.029 without the fuel shortage variables, but both estimates had large standard errors. However, Gately's study was beset by numerous statistical problems, which raise serious questions about the reliability of its results.[653]

More recently, Matos and Silva (2011) analyzed road freight transportation sector data for the years 1987–2006 in Portugal to identify the determinants of demand for HDV freight transportation.[654] Using a reduced-form equation relating HDV use (measured in ton-km) to economic activity (GDP) and the energy cost of HDV use (measured in fuel cost per ton-km carried), these authors estimated the elasticity of HDV ton-km with respect to energy costs to be −0.241. An important strength of Matos and Silva's study is that it also estimated this same elasticity using a procedure that accounted for the effect of potential mutual causality between HDV ton-km and energy costs, and arrived at an identical value.

Differences between HDV use and the level of highway service in Portugal and in the U.S. might limit the applicability of Matos and Silva's result to the U.S. The volume and mix of commodities could differ between the two nations, as could the levels of congestion on their respective highway networks, transport distances, the extent of intermodal competition, and the characteristics of HDVs themselves. HDVs also operate over a more limited highway network in Portugal than in the United States. Unfortunately, it is difficult to anticipate how these differences might cause Matos and Silva's elasticity estimates to differ from what we might find in the U.S. Finally, their analysis focused on HDV freight transport and did not consider non-freight uses of HDVs, which somewhat limits its usefulness in the analysis of this proposed rulemaking.

De Borger and Mulalic (2012) examined the determinants of fuel use in the Denmark HDV freight transport sector for the years 1980–2007. The authors developed a system of equations that capture linkages among the demand for HDV freight transport, HDV fleet characteristics, and HDV fuel consumption.[655] As De Borger and Mulalic state, ''we precisely define and estimate a rebound effect of improvements in fuel efficiency in the trucking industry: Behavioral adjustments in the industry imply that an exogenous improvement in fuel efficiency reduces fuel use less than proportionately. Our best estimate of this effect is approximately 10 percent in the short run and 17 percent in the long run, so that a 1 percent improvement in fuel efficiency reduces fuel use by 0.90 percent (short-run) to 0.83 percent (long-run).''

While De Borger and Mulalic capture a number of important responses that contribute to the rebound effect, some caution is appropriate when using their results to estimate the VMT rebound effect for this proposal. Like the Matos and Silva study, this study examined HDV activity in another country, Denmark, which has a less-developed highway system, lower levels of freight railroad service than the U.S., and is also likely to have a different composition of freight shipping activity. Although the effect of some of these differences is unclear, greater competition from rail shipping in the U.S. and the resulting potential for lower trucking costs to divert some rail freight to truck could cause the VMT rebound effect to be larger in the U.S. than De Borger and Mulalic's estimate for Denmark.

On the other hand, if freight networks are denser and commodity types are more homogenous in Denmark than the U.S., then shippers may have wider freight trucking options. If this is the case, shippers in Denmark might be more sensitive to changes in freight costs, which could cause the rebound effect in Denmark to be larger than the U.S. Like the Matos and Silva study, this analysis also focuses on freight trucking and does not consider non-freight HDVs (*e.g.* vocational vehicles). We have been unable to identify adequate data to employ De Borger and Mulalic's model for the U.S. (mainly because time-series data on freight carriage by trucks, driver wages, and vehicle prices in the U.S. are limited).

The Volpe National Transportation Systems Center previously has developed a series of travel forecasting models for the Federal Highway Administration (FHWA).[656] Work conducted by the Volpe Center during 2009–2011 to develop the original version of FHWA's forecasting model was presented in the Regulatory Impact Analysis for the HD GHG Phase 1 rule (see Table 9–2 in that document, which is reproduced below as Table IX–11).[657] In the analysis for the Phase 1 rule, Volpe estimated both state-level and national aggregate models to forecast HDV single unit and combination truck VMT that included fuel cost per mile as an explanatory variable. This analysis used data from 1970–2008 for its national aggregate model, and data for the 50 individual states from 1994–2008 for its state-level model.[658] [659]

[652] Gately, D., The U.S. Demand for Highway Travel and Motor Fuels, The Energy Journal, Volume 11, No. 3, July 1990, pp.59–73.

[653] The most important of these problems—similar historical time trends in the model's dependent variable and the measures used to explain its historical variation—can lead to ''spurious regressions,'' or the appearance of behavioral relationships that are simply artifacts of the similarity (or correlation) in historical trends among the model's variables.

[654] Matos, F.J.F., and Silva, F.J.F., ''The Rebound Effect on Road Freight Transport: Empirical Evidence from Portugal,'' Energy Policy, 39, 2011, pp. 2833–2841.

[655] De Borger, B. and Mulalic, I., ''The determinates of fuel use in the trucking industry—volume, fleet characteristics and the rebound effect'', Transportation Policy, Volume 24, November 2012, pp. 284–295.

[656] FHWA Travel Analysis Framework Development of VMT Forecasting Models for Use by the Federal Highway Administration May 12, 2014 *http://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_model_dev.pdf*. Volpe's work was advised by a panel of approximately 20 experts in the measurement, analysis, and forecasting of travel, including academic researchers, transportation consultants, and members of local, state, and federal government transportation agencies. It was also summarized in the paper ''Developing a Multi-Level Vehicle Miles of Travel Forecasting Model,'' November, 2011, which was presented to the Transportation Research Board's 91st Annual Meeting in January, 2012.

[657] EPA/NHTSA, August 2011. Chapter 9.3.3, Final Rulemaking to Establish Greenhouse gas Emission Standards & Fuel Efficiency Standards for Medium-and Heavy-Duty Engines and Vehicles, Regulatory Impact Analysis. EPA–420–R–11–901. (*http://www.epa.gov/otaq/climate/documents/420r11901.pdf*).

[658] Combination trucks are defined as ''all [Class 7/8] trucks designed to be used in combination with one or more trailers with a gross vehicle weight rating over 26,000 lbs.'' (AFDC, 2014; ORNL, 2013c). Single-unit trucks are defined as ''single frame trucks that have 2-axles and at least 6 tires or a gross vehicle weight rating exceeding 10,000 lbs.'' (FHWA, 2013).

[659] The national-level and functional class VMT forecasting models utilize aggregate time-series data for the nation as a whole, so that only a single measure of each variable is available during each time period (*i.e.,* year). In contrast, the state-level

Continued

Volpe analysts tested a large number of different specifications for its national and state level models that incorporated the effects of factors such as aggregate economic activity and its composition, the volume of U.S. exports and imports, and factors affecting the cost of producing trucking services (*e.g.,* driver wage rates, truck purchase prices, and fuel costs), and the extent and capacity of the U.S. and states' highway networks.

Table IX–11 summarizes Volpe's Phase 1 estimates of the elasticity of truck VMT with respect to fuel cost per mile.[660] As it indicates, these estimates vary widely, and the estimates based on state-level and national data differ substantially.

TABLE IX–11—SUMMARY OF VOLPE CENTER ESTIMATES OF ELASTICITY OF TRUCK VMT WITH RESPECT TO FUEL COST PER MILE

Truck type	National data		State data	
	Short run	Long run	Short run	Long run
Single Unit	13–22%	28–45%	3–8%	12–21%
Combination	N/A	12–14%	N/A	4–5%

Volpe staff conducted additional analysis of the models that yielded the estimates of the elasticity of truck VMT with respect to fuel cost per mile reported in Table IX–11, using updated information on fuel costs and other variables appearing in these models, together with revised historical data on truck VMT provided by DOT's Federal Highway Administration. The newly-available data, statistical procedures employed in conducting this additional analysis, and its results are summarized in materials that can be found in the docket for this rulemaking. This new Volpe analysis was not available at the time the agencies selected the values of the rebound effect for this proposal, but the agencies will consider this work and any other work in the analysis supporting the final rule.

Finally, EPA has contracted with Energy and Environmental Research Associates (EERA), LLC to analyze the HDV rebound effect for regulatory assessment purposes. Excerpts of EERA's initial report to EPA are included in the docket and contain detailed qualitative discussions of the rebound effect as well as data sources that could be used in quantitative analysis.[661] EERA also conducted follow-on quantitative analyses focused on estimating the impact of fuel prices on VMT and fuel consumption. We have included a working paper in the docket on this work, and we seek comment on this work.[662] Note that EERA's working paper was not available at the time the agencies conducted the analysis of the rebound effect for this proposal, but the agencies will consider this work and any other work in the analysis supporting the final rule.

There are reasons to be cautious about interpreting the elasticities from the studies reviewed in this section as a measure of VMT rebound resulting from our proposed standards. For example, vehicle capacity and loaded weight can vary dynamically in the HDV sector—possibly in response to changes in fuel price and fuel efficiency—and data on these measures are limited. This makes it difficult to confidently infer a direct relationship between trucking output (*e.g.,* ton-miles carried) and VMT assuming a constant average payload.

In addition, fuel cost per mile—calculated by multiplying fuel price per gallon by fuel efficiency in gallons per mile—and fuel price may be imprecise proxies for an improvement in fuel efficiency, because the response of VMT to these variables may differ. For example, if truck operators are more attentive to variation in fuel prices than to changes in fuel efficiency, then fuel price or fuel cost elasticities may overstate the true magnitude of the rebound effect.

Similarly, there is some evidence in the literature that demand for crude petroleum and refined fuels is more responsive to increases than to decreases in their prices, although this research is not specific to the HDV sector.[663] Since improved fuel efficiency typically causes fuel costs for HDVs to fall (and assuming fuel costs are not fully offset by increases in vehicle purchase prices), fuel price or cost elasticities derived from historical periods when fuel prices were increasing or fuel efficiency was declining may also overstate the magnitude of the rebound effect. An additional unknown is that HDV operators may factor fuel prices and fuel costs into their decision-making about rates to charge for their service differently from the way they incorporate initial vehicle purchase costs.

Despite these limitations, elasticities with respect to fuel price and fuel cost can provide some insight into the magnitude of the HDV VMT rebound effect. The agencies request comment on all of the studies presented in this section.

(b) Freight Price Elasticities

Freight price elasticities measure the percent change in demand for freight in response to a percent change in freight prices, controlling for other variables that may influence freight demand such as GDP, the extent that goods are traded internationally, and road supply and capacity. This type of elasticity is only applicable to the HDV subcategory of freight trucks (*i.e.,* combination tractors and vocational vehicles that transport freight). One desirable attribute of such measures for purposes of this analysis is that they show the response of freight

VMT models have an additional data dimension, since both their dependent variable (VMT) and most explanatory variables have 51 separate observations available for each time period (one for each of the 50 states as well as Washington, DC). In this context, the states represent a ''cross-section,'' and a continuous annual sequence of these cross-sections is available.

[660] One drawback of the fuel cost measure employed in Volpe's models is that it is based on estimates of fuel economy derived from truck VMT and fuel consumption, which introduces the potential for mutual causality (or ''simultaneity'') between VMT and the fuel cost measure and makes the effect of the latter difficult to isolate. This may cause their estimates of the sensitivity of truck VMT to fuel costs to be inaccurate, although the direction of any resulting bias is difficult to anticipate.

[661] EERA (2014), ''Research to Inform Analysis of the Heavy-Duty vehicle Rebound Effect'', Excerpts of Draft Final Report of Phase 1 under EPA contract EP–C–13–025.

[662] EERA (2015), ''Working Paper on Fuel Price Elasticities for Heavy Duty Vehicles'', Draft Final Report of Phase 2 under EPA contract EP–C–11–046.

[663] Gately, D. 1993. The Imperfect Price-Reversibility of World Oil Demand. The Energy Journal, International Association for Energy Economics, vol. 14 (4), pp. 163–182; Dargay, J.M., Gately, D. 1997. The demand for transportation fuels: Imperfect price-reversibility? Transportation Research Part B 31(1); and Sentenac-Chemin, E., 2012. Is the price effect on fuel consumption symmetric? Some evidence from an empirical study. Energy Policy, vol. 41, pp. 59–65.

trucking activity to changes to trucking rates, including changes that result from fuel cost savings as well as increases in HDV technology costs.[664]

Freight price elasticities, however, are imperfect proxies for the rebound effect in freight trucks for a number of reasons.[665] For example, in order to apply these elasticities we must assume that our proposed rule's impact on fuel and vehicle costs is fully reflected in freight rates. This may not be the case if truck operators adjust their profit margins or other operational practices (*e.g.,* loading practices, truck driver's wages) instead of freight rates. It is not well understood how trucking firms respond to different types of cost changes (*e.g.,* changes to fuel costs versus labor costs).

Freight price elasticity estimates in the literature typically measure freight activity in tons or ton-miles, rather than VMT. As discussed in the previous section, average truck capacity and payload in the HDV sector varies dynamically—possibly in response to changes in fuel price and fuel efficiency—and data on these measures are limited. This makes it difficult to confidently infer a direct relationship between ton-miles and VMT by assuming a constant average payload. Inferring a direct relationship between tons and VMT is even less straightforward. Additionally, there are significant limitations on national freight rate and freight truck ton-mile data in the U.S., making it difficult to confidently measure the impact of a change in freight rates on ton-miles.[666]

Finally, freight price elasticity estimates in the literature vary significantly based on commodity type, length of haul, region, availability of alternative modes (discussed further in Section IX.E.b.iii below), and functional form of the model (*i.e.,* log-linear, linear, translog) making it difficult to confidently apply any single estimate reported in the literature to nationwide freight activity. For example, elasticity estimates for longer trips tend to be larger in magnitude than those for shorter trips, while demand to ship bulk commodities tends to be less elastic than for non-bulk commodities.

Although these factors explain some of the differences among reported estimates, much of the observed variation cannot be explained quantitatively. For example, one study that controlled for mode, commodity class, demand elasticity measure (*i.e.,* tons or ton-miles), model estimation form, country, and temporal nature of data only accounted for about half of the observed variation.[667]

(c) Mode Shift Case Study

Although the total demand for freight transport is generally determined by economic activity, there is often the choice of shipping freight on modes other than HDVs. This is because the United States has extensive rail, waterway, pipeline, and air transport networks in addition to an extensive highway network; these networks often closely parallel each other and are often viable choices for freight transport for many long-distance shipping routes within the continental U.S. If rates for one mode decline, demand for that mode is likely to increase, and some of this new demand could represent shifts from other modes.[668] The ''cross-price elasticity of demand,'' which measures the percentage change in demand for shipping by another mode (*e.g.,* rail) given a percentage change in the price of HDV freight transport services, provides a measure of the importance of such mode shifting. Aggregate estimates of cross-price elasticities vary widely,[669] and there is no general consensus on the most appropriate value to use for analytical purposes.

When considering intermodal shift, one of the most relevant kinds of shipments are those that are competitive between rail and HDV modes. These trips generally include long-haul shipments greater than 500 miles, which weigh between 50,000 and 80,000 lbs (the legal road limit in many states). Special kinds of cargo like coal and short-haul deliveries are of less interest because they are generally not economically transferable between HDV and rail modes, so they would not be expected to shift modes except under an extreme price change. However, to the best of our knowledge, the total amount of freight that could potentially be subject to mode shifting has not been studied extensively.

In order to explore the potential for HDV fuel efficiency standards to produce economic conditions that favor a mode shift from rail to HDVs, EPA commissioned GIFT Solutions, LLC to perform case studies on the HD GHG Phase 1 rule using a number of data sources, including the Commodity Flow Survey, interviews with trucking firms, and the Geospatial Intermodal Freight Transportation (GIFT) model developed by Winebrake and Corbett, which includes information on infrastructure and other route characteristics in the U.S.[670] [671]

A central assumption in the case studies was that economic conditions would favor a shift from rail to HDVs if either the price per ton-mile to ship a commodity by HDV, or the price to ship a given quantity of a commodity by HDV, became lower relative to rail transport options post-regulation. The results of the case studies indicate that the HD Phase 1 rule would not seem to create obvious economic conditions that lead to a mode shift from rail to truck, but there are a number of limitations and caveats to this analysis, which are discussed in the final report to EPA by GIFT.[672] [673] For example, even if trucking did not become less expensive than rail post-regulation, a relative decrease in the truck versus rail rates might be enough to produce a shift, given that other factors could influence shippers' decisions on modal choice. The study did not, however, consider these other factors such as time-of-delivery and modal capacity. As another example, the analysis assumes all fuel cost savings and incremental vehicle

[664] Note however that a percent change in freight activity in response to a percent change in freight rates should theoretically be larger than a percent change in freight activity in response to a percent change in fuel efficiency because fuel efficiency only impacts a portion of freight operating costs (*e.g.,* fuel and vehicle costs, but not likely driver wages or highway tolls).

[665] Winebrake, J.J., Green, E.H., Comer, B., Corbett, J.J., Froman, S., 2012. Estimating the direct rebound effect for on-road freight transportation. Energy Policy 48, 252–259.

[666] See, for example, Appendix E in EERA (2014), ''Research to Inform Analysis of the Heavy-Duty Vehicle Rebound Effect'', Draft Final Report of Phase 1 under EPA contract EP–C–13–025.

[667] Li, Z., D.A. Hensher, and J.M. Rose, *Identifying sources of systematic variation in direct price elasticities from revealed preference studies of inter-city freight demand.* Transport Policy, 2011.

[668] Rail lines in parts of the U.S. are thought to be currently oversubscribed. If that is the case, and new freight demand is already being satisfied by trucks, then this would limit the potential for intermodal freight shifts between trucks and rail as the result of this proposed rule.

[669] Winebrake, J.J., Green, E.H., Comer, B., Corbett, J.J., Froman, S., 2012. Estimating the direct rebound effect for on-road freight transportation. Energy Policy 48, 252–259.

[670] Winebrake, James and James J. Corbett (2010). ''Improving the Energy Efficiency and Environmental Performance of Goods Movement,'' in Sperling, Daniel and James S. Cannon (2010) Climate and Transportation Solutions: Findings from the 2009 Asilomar Conference on Transportation and Energy Policy. See *http://www.its.ucdavis.edu/events/2009book/Chapter13.pdf.*

[671] Winebrake, J.J.; Corbett, J.J.; Falzarano, A.; Hawker, J.S.; Korfmacher, K.; Ketha, S.; Zilora, S., Assessing Energy, Environmental, and Economic Tradeoffs in Intermodal Freight Transportation, *Journal of the Air & Waste Management Association,* 58(8), 2008 (Docket ID: EPA–HQ–OAR–2010–0162–0008).

[672] See GIFT Solutions, LLC, ''Potential for Mode Shift due to Heavy Duty Vehicle Fuel Efficiency Improvements''. February, 2012.

[673] Winebrake, James, J. Corbett, J. Silberman, E. Erin, & B. Comer, 2012. Potential for Mode Shift due to Heavy Duty Vehicle Fuel Efficiency Improvements: A Case Study Approach. GIFT Solutions, LLC.

costs from the HD Phase 1 rule would be passed on to shippers via changes in freight rates, even though the analysis found some evidence that this might not occur (in two cases, the charges for shipping a truckload over a given route and distance were the same despite differences in payloads that should have been reflected in their fuel costs). Given these limitations, more work is needed in this area to explore the potential for mode shift in response to HD fuel efficiency standards.

(d) Case Study Using Freight Price Elasticities

Cambridge Systematics, Inc. (CSI) employed a case study approach using freight price elasticity estimates in the literature to show several examples of the magnitude of the HDV rebound effect.[674] In their unpublished paper commissioned by the National Research Council of the National Academies in support of its 2010 HDV report, CSI estimated the effect on HDV VMT from a net decrease in operating costs associated with fuel efficiency improvements, using two different technology cost and fuel savings scenarios for Class 8 combination tractors. Scenario 1 increased average fuel efficiency of the tractor from 5.59 miles per gallon to 6.8 miles per gallon, with an additional cost of $22,930 for purchasing the improved tractor. Scenario 2 increased the average fuel efficiency to 9.1 miles per gallon, at an incremental cost of $71,630 per tractor. Both of these scenarios were based on the technologies and targets from a report authored by the Northeast States Center for a Clean Air Future (NESCCAF) and International Council on Clean Transportation (ICCT).[675]

The CSI estimates were based on a range of direct (or ''own-price'') freight elasticities (-0.5 to -1.5)[676] and cross-price freight elasticities (0.35 to 0.59)[677] obtained from the literature.[678] In their calculations, CSI assumed 142,706 million miles of tractor VMT and 1,852 billion ton-miles were affected. The tractor VMT was based on the Bureau of Transportation Statistics' (BTS) estimate of highway miles for combination tractors in 2006, and the rail ton-miles were based on the BTS estimate of total railroad miles during 2006. This assumption is likely to overstate the rebound effect, since not all freight shipments occur on routes where tractors and rail service shipments compete directly. Nevertheless, this assumption appears to be reasonable in the absence of more detailed information on the percentage of total miles and ton-miles that are subject to potential mode shifting.

For CSI's calculations, all costs except fuel costs and vehicle costs were taken from a 2008 ATRI study.[679] It is not clear from the report how the new vehicle costs were incorporated into CSI's calculations of per-mile tractor operating costs. For example, neither the ATRI report nor the CSI report discusses assumptions about depreciation, useful lifetimes of tractors, and the opportunity cost of capital.

Based on these two scenarios, CSI estimated the change in tractor VMT in response to a net decrease in operating costs (*i.e.,* accounting for fuel cost and changes in tractor purchase costs) associated with fuel efficiency improvement of 11–31 percent for Scenario 1 and 5–16 percent for Scenario 2, without accounting for any fuel savings from reduced rail service. When the fuel savings from reduced rail usage were included in the calculations, they estimated the change in tractor VMT in response to a net decrease in operating costs associated with fuel efficiency improvement would be 9–30 percent for Scenario 1, and 3–15 percent for Scenario 2.

Note that these estimates reflect changes to tractor VMT with respect to total operating costs, so they should theoretically be larger than a percent change in tractor VMT with respect to a percent change in fuel efficiency because fuel efficiency only impacts a portion of truck operating costs (*e.g.,* fuel and vehicle costs, but not likely driver wages or highway tolls).

CSI included caveats associated with these calculations. For example, their report states that freight price elasticity estimates derived from the literature are ''heavily reliant on factors including the type of demand measures analyzed (vehicle-miles of travel, ton-miles, or tons), geography, trip lengths, markets served, and commodities transported.'' These factors can increase variability in the results. Also, estimates in CSI's study have the limitation of using freight price elasticities to estimate the HDV rebound effect discussed previously in Section IV.D.2.b.

(e) Simulation Model Study Using Freight Price Elasticities

Guerrero (2014) constructs a freight simulation model of the California trucking sector to measure the impact of fuel saving investments and fleet management on GHG emissions.[680] Rather than estimating these impacts using econometric analysis of raw data, the study uses values from the existing literature. Guerrero determines that ''. . . improving the performance of trucking also increases the number of trips demanded because the market price also decreases. This 'rebound' effect offsets around 40–50 percent of these vehicle efficiency emission reductions, with 9–14 percent of the effect coming from increased pavement deterioration and 31–36 percent coming from increased fuel combustion.'' Note that to the extent that trip lengths also vary in response to improvements in HDV fuel efficiency, changes in the number of HDV trips may not exactly reflect changes in the total number of miles the vehicles are operated.

However, these findings are based on freight price elasticities, which—as we discuss in Section IV.D.2.b and in the context of the CSI study above—have significant limitations. The study also simulates only one state's freight network (California), which may not be a good representation of national activity.

(3) How the Agencies Estimated the HDV Rebound Effect for This Proposal

(a) Values Used in the Phase 1 Analysis

At the time the agencies conducted their analysis of the Phase 1 fuel efficiency and GHG emissions standards, the only evidence on the HDV rebound effect were the previously

[674] Cambridge Systematics, Inc., Assessment of Fuel Economy Technologies for Medium and Heavy Duty Vehicles: Commissioned Paper on Indirect Costs and Alternative Approaches, 2009.

[675] Northeast States Center for a Clean Air Future, Southeast Research Institute, TIAX, LLC., and International Council on Clean Transportation, *Reducing Heavy-Duty Long Haul Truck Fuel Consumption and CO_2 Emissions,* September 2009. See *http://www.nescaum.org/documents/heavy-duty-truck-ghg_report_final-200910.pdf.*

[676] Graham and Glaister, ''Road Traffic Demand Elasticity Estimates: A Review,'' Transport Reviews Volume 24, 3, pp. 261–274, 2004.

[677] Based upon a study for the National Cooperative Highway Research Program by Cambridge Systematics, Inc., *Characteristics and Changes in Freight Transportation Demand: A Guidebook for Planners and Policy Analysts Phase II Report,* National Cooperative Highway Research Program Project 8–30, June 1995.

[678] The own (*i.e.,* self) price elasticity provides a measure for describing how the volume of truck shipping (demand) changes with its price while the cross-price elasticity provides a measure for describing how the volume of rail shipping changes with *truck* price. In general, an elasticity describes the percent change in one variable (*e.g.* demand for trucking) in response to a percent-change in another (*e.g.* price of truck operations).

[679] American Transportation Research Institute, ''An Analysis of the Operational Costs of Trucking'', October 2008.

[680] Guerrero, Sebastian. Modeling fuel saving investments and fleet management in the trucking industry: The impact of shipment performance on GHG emissions. Transportation Research Part E, May 2014.

described studies from CSI and the Volpe Center.[681] The agencies determined that this evidence did not lend itself to a specific quantitative value for use in the analysis. Rather, based on a qualitative assessment of this evidence informed by the agencies' best professional judgement, the agencies chose rebound effects of 15 percent for vocational vehicles and 5 percent for combination tractors, both of which were toward the lower end of the range of values from these studies. The agencies found no evidence on the rebound effect for HD pickup trucks and vans, but concluded it would be inappropriate to use the values selected for vocational vehicles or combination tractors for those vehicles. Because the usage patterns of HD pickup trucks and vans can more closely resemble those of large light-duty vehicles, the agencies used our judgement to select the 10 percent rebound effect we had employed in our most recent light-duty rulemaking to analyze the Phase 1 standards for 2b/3 vehicles.

(b) How the Agencies Analyzed VMT Rebound in This Proposal

After considering the new evidence that has become available since the HD Phase 1 final rule, the agencies elected to continue using the rebound effect estimates we used previously in the HD Phase 1 rule in our analysis of Phase 2 proposed standards. In arriving at this decision, the agencies considered the shortcomings and limitations of the newly-available studies described previously, particularly the limited applicability of the two published studies using data from European nations to the U.S. context. After weighing these attributes of the more recent studies, the agencies concluded that we had insufficient evidence to justify revising the rebound effect values that were used in the Phase 1 analysis.

In our assessment, we do not differentiate between short-run and long-run rebound effects, although these effects may differ. The vocational and combination truck estimates are based on the Volpe Center analysis presented in the HD Phase 1 rule and the case study from CSI. As with the HD Phase 1 rule, we did not find any literature specifically examining the HD pickup and truck sector. Since these vehicles are used for very different purposes than combination tractors and vocational vehicles, and they are more similar in use to large light-duty vehicles, we have chosen the light-duty rebound effect of 10 percent used in the final rule establishing fuel economy and GHG standards for MYs 2017–2025 light-duty vehicles in our analysis of HD pickup trucks and vans.

While for this proposal, the agencies have selected to use these rebound effect values of 5 percent for combination tractors, 10 percent for heavy duty pickup trucks and vans and 15 percent for vocational vehicles, we acknowledge the literature shows a wide range of rebound effect estimates. Therefore, we will review and consider revising these estimates in the final rule, taking into consideration all available data and analysis, including submissions from public commenters and new research on the rebound effect.

It should be noted that the rebound estimates we have selected for our analysis represent the VMT impact from our proposed standards with respect to changes in the fuel cost per mile driven. As described previously, the HDV rebound effect should ideally be a measure of the change in fuel consumed with respect to the change in *overall* operating costs due to a change in HDV fuel efficiency. Such a measure would incorporate all impacts from our proposal, including those from incremental increases in vehicle prices that reflect costs for improving their fuel efficiency. Therefore, VMT rebound estimates with respect to fuel costs per mile must be ''scaled'' to apply to total operating costs, by dividing them by the fraction of total operating costs accounted for by fuel.

The agencies made simplifying assumptions in the VMT rebound analysis for this proposal, similar to the approach taken during the development of the HD GHG Phase 1 final rule. However, for the HD Phase 2 final rulemaking, we plan to use a more comprehensive approach. Due to timing constraints during the development of this proposal, the agencies did not have the technology package costs for each of the alternatives prior to the need to conduct the inventory analysis, except for the pickup truck and van category in analysis Method A. Therefore, the same ''overall'' VMT rebound values were used for Alternatives 2 through 5 (as discussed in Chapter 8.3.3 of the Draft RIA and analyzed in Chapter 6 of the Draft RIA), despite the fact that each alternative results in a different change in incremental technology and fuel costs. For the final rulemaking, we plan to determine VMT rebound separately for each HDV category and for each alternative. Tables 64 through 66 in Chapter 7 of the Draft RIA present VMT rebound for each HDV sector that we estimated for the preferred alternative. These VMT impacts are reflected in the estimates of total fuel savings and reductions in emissions of GHG and other air pollutants presented in Section VI and VII of this preamble for all categories.

Section 9.3.3 in the draft RIA provides more details on our assessment of HDV VMT rebound. We invite comment on our approach, the rebound estimates, and the related assumptions we made. In particular, we invite comment on the most appropriate methodology for factoring new vehicle purchase or leasing costs into the per-mile operating costs. For the purposes of this proposal, we have not taken into account any potential fuel savings or GHG emission reductions from the rail sector due to mode shift because estimates of this effect seem too speculative at this time. We invite comment on this assumption, as well as suggestions on alternative modeling frameworks that could be used to assess mode shifting implications of our proposed regulations. Similarly, we have not taken into account any fuel savings or GHG emissions reductions from the potential shift in VMT from older HDVs to newer, more efficient HDVs because we have found no evidence of this potential effect from fuel efficiency standards. We invite comment on suggested modeling frameworks or data that could be used to assess the potential for activity to shift from older to newer, more efficient HDVs in response to our proposed standards.

Note that while we focus on the VMT rebound effect in our analysis of this proposed rule, there are at least two other types of rebound effects discussed in the economics literature. In addition to VMT rebound effects, there are ''indirect'' rebound effects, which refers to the purchase of other goods or services (that consume energy) with the costs savings from energy efficiency improvements; and ''economy-wide'' rebound effects, which refers to the increased demand for energy throughout the economy in response to the reduced market price of energy that happens as a result of energy efficiency improvements.

Research on indirect and economy-wide rebound effects is nascent, and we have not identified any that attempts to quantify indirect or economy-wide rebound effects for HDVs. In particular, the agencies are not aware of any data to indicate that the magnitude of indirect or economy-wide rebound effects, if any, would be significant for this proposed rule.[682] Therefore, we rely

[681] The Gately study was also available, however, the agencies were not aware of the work at the time.

[682] One entity sought reconsideration of the Phase 1 rule on the grounds that indirect rebound effects

Continued

the same analysis of vehicle miles traveled to estimate the rebound effect in this proposal that we did for the HD Phase 1 rule, where we attempted to quantify only rebound effects from our rule that impact HDV VMT. We welcome comments and any new work in this area that helps to assess and quantify different rebound effects that could result from improvements in HDV efficiency, including different types of more intensive truck usage that affect fuel consumption but not VMT such as loaded weight, truck routing, and scheduling.

In order to test the effect of alternative assumptions about the rebound effect, NHTSA examined the sensitivity of its estimates of benefits and costs of the Phase 2 Preferred Alternative for HD pickups and vans to alternative assumptions about the rebound effect. While the main analysis for pickups and vans assumes a 10 percent rebound effect, the sensitivity analysis estimates the benefits and costs of the proposed standards under the assumptions of 5, 15, and 20 percent rebound effects.

Alternative values of the rebound effect change the estimates of benefits and costs from the proposed standards in three ways. First, higher values of the rebound effect increase the amount of additional VMT that results from improved fuel efficiency; this increases costs associated with additional congestion, accidents, and noise, thus increasing total costs associated with the proposed standards. Conversely, smaller values of the rebound effect reduce costs from additional congestion, accidents, and noise, so they reduce total costs of the proposed standards. Larger increases in VMT associated with higher values of the rebound effect reduce the value of fuel savings and related benefits (such as reductions in GHG emissions) by progressively larger amounts, while smaller values of the rebound effect cause smaller reductions in these benefits. At the same time, however, a higher rebound effect generates larger benefits from increased vehicle use, while a smaller rebound effect reduces these benefits. Thus the impact of alternative values of the rebound effect on total benefits from the proposed standards depends on the exact magnitudes of these latter two effects. On balance, these three effects can cause net benefits to increase or decrease for alternative values of the rebound effect.

TABLE IX–12—SENSITIVITY OF PREFERRED ALTERNATIVE IMPACTS UNDER DIFFERENT ASSUMPTIONS ABOUT REBOUND EFFECT FOR PICKUPS AND VANS, USING 3% DISCOUNT RATE

HD pickups and vans	Rebound effect			
	Main analysis		Sensitivity cases using alternative rebound assumptions	
	10%	5%	15%	20%
Fuel Reductions (Billion Gallons)	7.8	8.2	7.5	7.1
GHG Reductions (MMT CO_2 eq)	94.1	95.7	87.2	83.0
Total Costs ($ billion)	5.5	5.0	6.5	7.2
Total Benefits ($ billion)	23.5	23.0	22.9	22.8
Net Benefits ($ billion)	18.0	18.0	16.4	15.5

Table IX–12 summarizes the impact of these alternative assumptions on fuel and GHG emissions savings, total costs, total benefits, and net benefits. As it indicates, using a 5 percent value for the rebound effect reduces benefits and costs of the proposed standards by identical amounts, leaving net benefits unaffected. As the table also shows, rebound effects of 15 percent and 20 percent increase costs and reduce benefits compared to their values in the main analysis, thus reducing net benefits of the proposed standards. Nevertheless, the preferred alternative has significant net benefits under each alternative assumption about the magnitude of the rebound effect for HD pickups and vans. Thus, these alternative values of the rebound effect would not have affected the agencies' selection of the preferred alternative, as that selection is based on NHTSA's assessment of the maximum feasible fuel efficiency standards and EPA's selection of appropriate GHG standards to address energy security and the environment.

F. Impact on Class Shifting, Fleet Turnover, and Sales

The agencies considered two additional potential indirect effects which may lead to unintended consequences of the program to improve the fuel efficiency and reduce GHG emissions from HD trucks. The next sections cover the agencies' qualitative discussions on potential class shifting and fleet turnover effects.

(1) Class Shifting

Heavy-duty vehicles are typically configured and purchased to perform a function. For example, a concrete mixer truck is purchased to transport concrete, a combination tractor is purchased to move freight with the use of a trailer, and a Class 3 pickup truck could be purchased by a landscape company to pull a trailer carrying lawnmowers. The purchaser makes decisions based on many attributes of the vehicle, including the gross vehicle weight rating of the vehicle, which in part determines the amount of freight or equipment that can be carried. If the proposed Phase 2 standards impact either the performance of the vehicle or the marginal cost of the vehicle relative to the other vehicle classes, then consumers may choose to purchase a different vehicle, resulting in the unintended consequence of increased fuel consumption and GHG emissions in-use.

The agencies, along with the NAS panel, found that there is little or no literature which evaluates class shifting between trucks.[683] NHTSA and EPA qualitatively evaluated the proposed rules in light of potential class shifting. The agencies looked at four potential cases of shifting:—From light-duty pickup trucks to heavy-duty pickup trucks; from sleeper cabs to day cabs;

had not been considered by the agencies and could negate all of the benefits of the standards. This assertion rested on an unsupported affidavit lacking any peer review or other indicia of objectivity. This affidavit cited only one published study. The study cited did not deal with vehicle efficiency, has methodological limitations (many of them acknowledged), and otherwise was not pertinent. EPA and NHTSA thus declined to reconsider the Phase 1 rule based on these speculative assertions. See generally 77 FR 51703–51704, August 27, 2012 and 77 FR 51502–51503, August 24, 2012.

[683] *See* 2010 NAS Report, page 152.

from combination tractors to vocational vehicles; and within vocational vehicles.

Light-duty pickup trucks, those with a GVWR of less than 8,500 lbs, are currently regulated under the existing GHG/CAFE Phase 1 program and will meet GHG/CAFE Phase 2 emission standards beginning in 2017. The increased stringency of the light-duty 2017–2025 MY vehicle rule has led some to speculate that vehicle consumers may choose to purchase heavy-duty pickup trucks that are currently regulated under the HD Phase 1 program if the cost of the light-duty regulation is high relative to the cost to buy the larger heavy-duty pickup trucks. Since fuel consumption and GHG emissions rise significantly with vehicle mass, a shift from light-duty trucks to heavy-duty trucks would likely lead to higher fuel consumption and GHG emissions, an untended consequence of the regulations. Given the significant price premium of a heavy-duty truck (often five to ten thousand dollars more than a light-duty pickup), we believe that such a class shift would be unlikely even absent this program. These proposed rules would continue to diminish any incentive for such a class shift because they would narrow the GHG and fuel efficiency performance gap between light-duty and heavy-duty pickup trucks. The proposed regulations for the HD pickup trucks, and similarly for vans, are based on similar technologies and therefore reflect a similar expected increase in cost when compared to the light-duty GHG regulation. Hence, the combination of the two regulations provides little incentive for a shift from light-duty trucks to HD trucks. To the extent that our proposed regulation of heavy-duty pickups and vans could conceivably encourage a class shift towards lighter pickups, this unintended consequence would in fact be expected to lead to lower fuel consumption and GHG emissions as the smaller light-duty pickups have significantly better fuel economy ratings than heavy-duty pickup trucks.

The projected cost increases for this proposed action differ between Class 8 day cabs and Class 8 sleeper cabs, reflecting our expectation that compliance with the proposed standards would lead truck consumers to specify sleeper cabs equipped with APUs while day cab consumers would not. Since Class 8 day cab and sleeper cab trucks perform essentially the same function when hauling a trailer, this raises the possibility that the higher cost for an APU equipped sleeper cab could lead to a shift from sleeper cab to day cab trucks. We do not believe that such an intended consequence would occur for the following reasons. The addition of a sleeper berth to a tractor cab is not a consumer-selectable attribute in quite the same way as other vehicle features. The sleeper cab provides a utility that long-distance trucking fleets need to conduct their operations—an on-board sleeping berth that lets a driver comply with federally-mandated rest periods, as required by the Department of Transportation Federal Motor Carrier Safety Administration's hours-of-service regulations. The cost of sleeper trucks is already higher than the cost of day cabs, yet the fleets that need this utility purchase them.[684] A day cab simply cannot provide this utility with a single driver. The need for this utility would not be changed even if the additional costs to reduce greenhouse gas emissions from sleeper cabs exceed those for reducing greenhouse gas emissions from day cabs.[685]

A trucking fleet could instead decide to put its drivers in hotels in lieu of using sleeper berths, and switch to day cabs. However, this is unlikely to occur in any great number, since the added cost for the hotel stays would far overwhelm differences in the marginal cost between day and sleeper cabs. Even if some fleets do opt to buy hotel rooms and switch to day cabs, they would be highly unlikely to purchase a day cab that was aerodynamically worse than the sleeper cab they replaced, since the need for features optimized for long-distance hauling would not have changed. So in practice, there would likely be little difference to the environment for any switching that might occur. Further, while our projected costs assume the purchase of an APU for compliance, in fact our proposed regulatory structure would allow compliance using a near zero cost software utility that eliminates tractor idling after five minutes. Using this compliance approach, the cost difference between a Class 8 sleeper cab and day cab due to our proposed regulations is small. We are proposing this alternative compliance approach reflecting that some sleeper cabs are used in team driving situations where one driver sleeps while the other drives. In that situation, an APU is unnecessary since the tractor is continually being driven when occupied. When it is parked, it would automatically eliminate any additional idling through the shutdown software. If trucking businesses choose this option, then costs based on purchase of APUs may overestimate the costs of this program to this sector.

Class shifting from combination tractors to vocational vehicles may occur if a customer deems the additional marginal cost of tractors due to the regulation to be greater than the utility provided by the tractor. The agencies initially considered this issue when deciding whether to include Class 7 tractors with the Class 8 tractors or regulate them as vocational vehicles. The agencies' evaluation of the combined vehicle weight rating of the Class 7 shows that if these vehicles were treated significantly differently from the Class 8 tractors, then they could be easily substituted for Class 8 tractors. Therefore, the agencies are proposing to continue to include both classes in the tractor category. The agencies believe that a shift from tractors to vocational vehicles would be limited because of the ability of tractors to pick up and drop off trailers at locations which cannot be done by vocational vehicles.

The agencies do not envision that the proposed regulatory program would cause class shifting within the vocational vehicle class. The marginal cost difference due to the regulation of vocational vehicles is minimal. The cost of LRR tires on a per tire basis is the same for all vocational vehicles so the only difference in marginal cost of the vehicles is due to the number of axles. The agencies believe that the utility gained from the additional load carrying capability of the additional axle would outweigh the additional cost for heavier vehicles.[686]

In conclusion, NHTSA and EPA believe that the proposed regulatory structure for HD trucks would not significantly change the current competitive and market factors that determine purchaser preferences among truck types. Furthermore, even if a small amount of shifting would occur, any resulting GHG impacts would likely to be negligible because any vehicle class that sees an uptick in sales is also being regulated for fuel efficiency. Therefore, the agencies did not include an impact of class shifting on the vehicle populations used to assess the benefits of the proposed program.

[684] A baseline tractor price of a new day cab is $89,500 versus $113,000 for a new sleeper cab based on information gathered by ICF in the ''Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for Heavy-Duty On-Road Vehicles'', July 2010. Page 3. Docket Identification Number EPA–HQ–OAR–2014—0827.

[685] The average marginal cost difference between sleeper cabs and day cabs in the proposal is roughly $2,500.

[686] The proposed rule projects the difference in costs between the HHD and MHD vocational vehicle technologies is approximately $30.

(2) Fleet Turnover and Sales Effects

A regulation that affects the cost to purchase and/or operate trucks could affect whether a consumer decides to purchase a new truck and the timing of that purchase. The term pre-buy refers to the idea that truck purchases may occur earlier than otherwise planned to avoid the additional costs associated with a new regulatory requirement. Slower fleet turnover, or low-buys, may occur when owners opt to keep their existing truck rather than purchase a new truck due to the incremental cost of the regulation.

The 2010 NAS HD Report discussed the topics associated with HD truck fleet turnover. NAS noted that there is some empirical evidence of pre-buy behavior in response to the 2004 and 2007 heavy-duty engine emission standards, with larger impacts occurring in response to higher costs.[687] However, those regulations increased upfront costs to firms without any offsetting future cost savings from reduced fuel purchases. In summary, NAS stated that:

> . . . during periods of stable or growing demand in the freight sector, pre-buy behavior may have significant impact on purchase patterns, especially for larger fleets with better access to capital and financing. Under these same conditions, smaller operators may simply elect to keep their current equipment on the road longer, all the more likely given continued improvements in diesel engine durability over time. On the other hand, to the extent that fuel economy improvements can offset incremental purchase costs, these impacts will be lessened. Nevertheless, when it comes to efficiency investments, most heavy-duty fleet operators require relatively quick payback periods, on the order of two to three years.[688]

The proposed regulations are projected to return fuel savings to the truck owners that offset the cost of the regulation within a few years. The effects of the regulation on purchasing behavior and sales will depend on the nature of the market failures and the extent to which firms consider the projected future fuel savings in their purchasing decisions.

If trucking firms account for the rapid payback, they are unlikely to strategically accelerate or delay their purchase plans at additional cost in capital to avoid a regulation that will lower their overall operating costs. As discussed in Section IX. A. this scenario may occur if this proposed program reduces uncertainty about fuel-saving technologies. More reliable information about ways to reduce fuel consumption allows truck purchasers to evaluate better the benefits and costs of additional fuel savings, primarily in the original vehicle market, but possibly in the resale market as well. In addition, the proposed standards are expected to lead manufacturers to install more fuel-saving technologies and promote their purchase; the increased availability and promotion may encourage sales.

Other market failures may leave open the possibility of some pre-buy or delayed purchasing behavior. Firms may not consider the full value of the future fuel savings for several reasons. For instance, truck purchasers may not want to invest in fuel efficiency because of uncertainty about fuel prices. Another explanation is that the resale market may not fully recognize the value of fuel savings, due to lack of trust of new technologies or changes in the uses of the vehicles. Lack of coordination (also called split incentives—see Section IX. A.) between truck purchasers (who may emphasize the up-front costs of the trucks) and truck operators, who would like the fuel savings, can also lead to pre-buy or delayed purchasing behavior. If these market failures prevent firms from fully internalizing fuel savings when deciding on vehicle purchases, then pre-buy and delayed purchase could occur and could result in a slight decrease in the GHG benefits of the regulation.

Thus, whether pre-buy or delayed purchase is likely to play a significant role in the truck market depends on the specific behaviors of purchasers in that market. Without additional information about which scenario is more likely to be prevalent, the agencies are not projecting a change in fleet turnover characteristics due to this regulation.

Whether vehicle sales appear to be affected by the HD Phase 1 standards could provide some insight into the impacts of the proposed standards. At the time of this proposed rule, sales data are not yet available for 2014 model year, the first year of the Phase 1 standards. In addition, any trends in sales are likely to be affected by macroeconomic conditions, which have been recovering since 2009–2010. As a result, it is unlikely to be possible, even when vehicle sales data are available, to separate the effects of the existing standards from other confounding factors.

G. Monetized GHG Impacts

(1) Monetized CO_2 Impacts—The Social Cost of Carbon (SC–CO_2)

We estimate the global social benefits of CO_2 emission reductions expected from the proposed heavy-duty GHG and fuel efficiency standards using the social cost of carbon (SC–CO_2) estimates presented in the 2013 *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (2013 SCC TSD).[689] (The SC–CO_2 estimates are presented in Table IX–11). We refer to these estimates, which were developed by the U.S. government, as ''SC–CO_2 estimates.'' The SC–CO_2 is a metric that estimates the monetary value of impacts associated with marginal changes in CO_2 emissions in a given year. It includes a wide range of anticipated climate impacts, such as net changes in agricultural productivity and human health, property damage from increased flood risk, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning. It is used in regulatory impact analyses to quantify the benefits of reducing CO_2 emissions, or the disbenefit from increasing emissions.

The SC–CO_2 estimates used in this analysis were developed over many years, using the best science available, and with input from the public. Specifically, an interagency working group (IWG) that included EPA, DOT, and other executive branch agencies and offices used three integrated assessment models (IAMs) to develop the SC–CO_2 estimates and recommended four global values for use in regulatory analyses. The SC–CO_2 estimates were first released in February 2010[690] and

[687] Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles; National Research Council; Transportation Research Board (2010). ''Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,'' (hereafter, ''NAS Report''). Washington, DC, the National Academies Press. Available electronically from the National Academies Press Web site at *http://www.nap.edu/catalog.php?record_id=12845.* pp. 150–151.

[688] *See* NAS Report, Note 687, page 151.

[689] Docket ID EPA–HQ–OAR–2014–0827, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,* Interagency Working Group on Social Cost of Carbon, with participation by Council of Economic Advisers, Council on Environmental Quality, Department of Agriculture, Department of Commerce, Department of Energy, Department of Transportation, Environmental Protection Agency, National Economic Council, Office of Energy and Climate Change, Office of Management and Budget, Office of Science and Technology Policy, and Department of Treasury (May 2013, Revised November 2013). Available at: *http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf.*

[690] Docket ID EPA–HQ–OAR–2009–0472–114577, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,* Interagency Working Group on Social Cost of Carbon, with participation by the Council of Economic Advisers, Council on Environmental Quality, Department of Agriculture, Department of Commerce, Department of Energy, Department of Transportation, Environmental Protection Agency, National Economic Council,

updated in 2013 using new versions of each IAM. These estimates were published in the 2013 SCC TSD. The 2013 update did not revisit the 2010 modeling decisions (*e.g.,* with regard to the discount rate, reference case socioeconomic and emission scenarios or equilibrium climate sensitivity). Rather, improvements in the way damages are modeled are confined to those that have been incorporated into the latest versions of the models by the developers themselves and used for analyses in peer-reviewed publications. The 2010 SCC Technical Support Document (2010 SCC TSD) provides a complete discussion of the methods used to develop these estimates and the 2013 SCC TSD presents and discusses the updated estimates.

The 2010 SCC TSD noted a number of limitations to the SC–CO_2 analysis, including the incomplete way in which the IAMs capture catastrophic and non-catastrophic impacts, their incomplete treatment of adaptation and technological change, uncertainty in the extrapolation of damages to high temperatures, and assumptions regarding risk aversion. Current IAMs do not assign value to all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature due to a lack of precise information on the nature of damages and because the science incorporated into these models understandably lags behind the most recent research. Nonetheless, these estimates and the discussion of their limitations represent the best available information about the social benefits of CO_2 reductions to inform benefit-cost analysis; see RIA of this rule and the SCC TSDs for additional details. The new versions of the models used to estimate the values presented below offer some improvements in these areas, although further work is warranted.

Accordingly, EPA and other agencies continue to engage in research on modeling and valuation of climate impacts with the goal to improve these estimates. The EPA and other federal agencies have considered the extensive public comments on ways to improve SC–CO_2 estimation received via the notice and comment periods that were part of numerous rulemakings. In addition, OMB's Office of Information and Regulatory Affairs sought public comment on the approach used to develop the SC–CO_2 estimates (78 FR 70586, November 26, 2013). The comment period ended on February 26, 2014, and OMB is reviewing the comments received. OMB also responded in January 2014 to concerns submitted in a Request for Correction on the SCC TSDs.[691]

The four global SC–CO_2 estimates, updated in 2013, are as follows: $13, $46, $68, and $140 per metric ton of CO_2 emissions in the year 2020 (2012$).[692] The first three values are based on the average SC–CO_2 from the three IAMs, at discount rates of 5, 3, and 2.5 percent, respectively. SC–CO_2 estimates for several discount rates are included because the literature shows that the SC–CO_2 is quite sensitive to assumptions about the discount rate, and because no consensus exists on the appropriate rate to use in an intergenerational context (where costs and benefits are incurred by different generations). The fourth value is the 95th percentile of the SC–CO_2 from all three models at a 3 percent discount rate. It is included to represent higher-than-expected impacts from temperature change further out in the tails of the SC–CO_2 distribution (representing less likely, but potentially catastrophic, outcomes). The SC–CO_2 increases over time because future emissions are expected to produce larger incremental damages as economies grow and physical and economic systems become more stressed in response to greater climate change. The SC–CO_2 values are presented in Table IX–11.

Applying the global SC–CO_2 estimates, shown in Table IX–13, to the estimated reductions in domestic CO_2 emissions for the proposed program, yields estimates of the dollar value of the climate related benefits for each analysis year. These estimates are then discounted back to the analysis year using the same discount rate used to estimate the SC–CO_2. For internal consistency, the annual benefits are discounted back to net present value terms using the same discount rate as each SC–CO_2 estimate (*i.e.* 5 percent, 3 percent, and 2.5 percent) rather than the discount rates of 3 percent and 7 percent used to derive the net present value of other streams of costs and benefits of the proposed rule.[693] The SC–CO_2 benefit estimates for each calendar year are shown in Table IX–14. The SC–CO_2 benefit estimates for each model year are shown in Table IX–15.

TABLE IX–13—SOCIAL COST OF CO^2, 2012–2050 [a]

(in 2012$ per metric ton)

Calendar year	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2012	$12	$37	$58	$100
2015	12	40	61	120
2020	13	46	69	140
2025	15	51	74	150
2030	17	56	81	170
2035	20	60	86	190
2040	23	66	93	210
2045	26	71	99	220
2050	28	77	100	240

Note:

[a] The SC-CO_2values are dollar-year and emissions-year specific and have been rounded to two significant digits. Unrounded numbers from the 2013 SCC TSD were used to calculate the CO_2 benefits.

Office of Energy and Climate Change, Office of Management and Budget, Office of Science and Technology Policy, and Department of Treasury (February 2010). Also available at: *http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.*

[691] OMB's 1/24/14 response to the petition is available at *https://www.whitehouse.gov/sites/default/files/omb/inforeg/ssc-rfc-under-iqa-response.pdf.*

[692] The 2013 SCC TSD presents the SC–CO_2 estimates in $2007. These estimates were adjusted to 2012$ using the GDP Implicit Price Deflator. Bureau of Economic Analysis, Table 1.1.9 Implicit Price Deflators for Gross Domestic Product; last revised on March 27, 2014.

[693] See more discussion on the appropriate discounting of climate benefits using SC–CO_2 in the 2010 SCC TSD. Other benefits and costs of proposed regulations unrelated to CO_2 emissions are discounted at the 3% and 7% rates specified in OMB guidance for regulatory analysis.

TABLE IX–14—UPSTREAM AND DOWNSTREAM ANNUAL CO_2 BENEFITS FOR THE GIVEN SC-CO_2 VALUE [a] USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[millions of 2012$] [b]

Calendar year	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2018	$13	$43	$65	$130
2019	26	91	130	270
2020	40	140	210	420
2021	92	330	500	1,000
2022	170	590	880	1,800
2023	250	860	1,300	2,600
2024	400	1,300	1,900	4,000
2025	540	1,800	2,600	5,500
2026	720	2,300	3,400	7,000
2027	890	2,900	4,200	8,900
2028	1,100	3,500	5,100	11,000
2029	1,300	4,200	5,900	13,000
2030	1,500	4,800	6,900	15,000
2035	2,500	7,400	11,000	23,000
2040	3,300	9,700	14,000	30,000
2050	5,000	14,000	19,000	42,000
NPV	22,000	100,000	160,000	320,000

Notes:

[a] The SC-CO_2 values are dollar-year and emissions-year specific.

[b] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE IX–15—UPSTREAM AND DOWNSTREAM DISCOUNTED MODEL YEAR LIFETIME CO_2 BENEFITS FOR THE GIVEN SC-CO_2 VALUE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[millions of 2012$] [a b]

Model year	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2018	$93	$380	$580	$1,100
2019	90	370	570	1,100
2020	87	360	560	1,100
2021	520	2,200	3,400	6,600
2022	540	2,300	3,500	6,900
2023	550	2,300	3,600	7,200
2024	870	3,700	5,800	11,000
2025	900	3,900	6,100	12,000
2026	920	4,000	6,300	12,000
2027	1,100	4,800	7,600	15,000
2028	1,100	4,800	7,600	15,000
2029	1,100	4,900	7,700	15,000
Sum	7,800	34,000	53,000	100,000

Notes:

[a] The SC-CO_2 values are dollar-year and emissions-year specific.

[b] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(2) Sensitivity Analysis—Monetized Non-CO_2 GHG Impacts

One limitation of the primary benefits analysis is that it does not include the valuation of non-CO_2 GHG impacts (*e.g.,* CH_4, N_2O, HFC-134a). Specifically, the 2010 and 2013 SCC TSDs do not include estimates of the social costs of non-CO_2 GHG emissions using an approach analogous to the one used to estimate the SC-CO_2. However, EPA recognizes that non-CO_2 GHG impacts associated with this rulemaking (*e.g.,* net reductions in CH_4,N_2O, and HFC-134a) would provide additional benefits to society. To understand the potential implication of omitting these benefits, EPA has conducted sensitivity analysis using two approaches: (1) An approximation approach based on the global warming potentials (GWP) of non-CO_2 GHGs, which has been used in previous rulemakings, and (2) a set of recently published SC-CH_4 and SC-N_2O estimates that are consistent with the modeling assumptions underlying the SC-CO_2 estimates (Marten et al. 2014). This section presents estimates of the non-CO_2 benefits of the proposed rulemaking using both approaches. Other unquantified non-CO_2 benefits are discussed in this section as well. Additional details are provided in the RIA of these rules.

Currently, EPA is undertaking a peer review of the application of the Marten et al. (2014) non-CO_2 social cost estimates in regulatory analysis. Pending a favorable peer review, EPA plans to include monetized benefits of CH_4 and N_2O emission reductions in the main benefit-cost analysis of the RIA for the final rule, using the directly modeled estimates of SC-CH_4 and SC-N_2O from Marten et al. EPA seeks comments on the use of directly modeled estimates for the social cost of non-CO_2 GHGs.

(a) Non-CO_2 GHG Benefits Based on the GWP Approximation Approach

In the absence of directly modeled estimates, one potential method for approximating the value of marginal non-CO_2 GHG emission reductions is to convert non-CO_2 emissions reductions to CO_2-equivalents that may then be valued using the SC-CO_2. Conversion to CO_2-equivalents is typically based on the global warming potentials (GWPs) for the non-CO_2 gases. This approach, henceforth referred to as the ''GWP approach,'' has been used in sensitivity analyses to estimate the non-CO_2 benefits in previous EPA rulemakings (see U.S. EPA 2012, 2013).[694] EPA has not presented these estimates in a main benefit-cost analysis due to the limitations associated with using the GWP approach to value changes in non-CO_2 GHG emissions, and considered the GWP approach as an interim method of analysis until social cost estimates for non-CO_2 GHGs, consistent with the SC-CO_2 estimates, were developed.

The GWP is a simple, transparent, and well-established metric for assessing the relative impacts of non-CO_2 emissions compared to CO_2 on a purely physical basis. However, as discussed both in the 2010 SCC TSD and previous rulemakings (*e.g.,* U.S. EPA 2012, 2013), the GWP approximation approach to measuring non-CO_2 GHG benefits has several well-documented limitations. These metrics are not ideally suited for use in benefit-cost analyses to approximate the social cost of non-CO_2 GHGs because the approach would assume all subsequent linkages leading to damages are linear in radiative forcing, which would be inconsistent with the most recent scientific literature. Detailed discussion of limitations of the GWP approach can be found in the RIA.

Similar to the approach used in the RIA of the *Final Rulemaking for 2017–2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards* (U.S. EPA, 2013), EPA applies the GWP approach to estimate the benefits associated with reductions of CH_4, N_2O and HFCs in each calendar year. Under the GWP Approach, EPA converted CH_4, N_2O and HFC-134a to CO_2 equivalents using the AR4 100-year GWP for each gas: CH_4 (25), N_2O (298), and HFC-134a (1,430).[695] These CO_2-equivalent emission reductions are multiplied by the SC-CO_2 estimate corresponding to each year of emission reductions. As with the calculation of annual benefits of CO_2 emission reductions, the annual benefits of non-CO_2 emission reductions based on the GWP approach are discounted back to net present value terms using the same discount rate as each SC-CO_2 estimate. The estimated non-CO_2 GHG benefits using the GWP approach are presented in Table IX–16 through Table IX–18. The total net present value of the GHG benefits for this proposed rulemaking would increase by about $760 million to $11 billion (2012$), depending on discount rate, or roughly 3 percent if these non-CO_2 estimates were included.

TABLE IX–16—ANNUAL UPSTREAM AND DOWNSTREAM CH_4 BENEFITS FOR THE GIVEN SC-CO_2 VALUE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE, USING THE GWP APPROACH [a b]

[$Millions of 2012$] [b]

Calendar year	CH_4			
	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2018	$0.3	$1.1	$1.6	$3.2
2019	0.6	2.2	3.3	6.6
2020	1.0	3.5	5.2	10
2021	3.1	11	17	33
2022	6.0	20	30	62
2023	8.8	30	45	93
2024	14	46	68	140
2025	19	62	91	190
2026	25	79	120	240
2027	30	99	140	300
2028	36	120	170	360
2029	43	140	200	420
2030	49	160	230	480
2035	82	240	350	760
2040	110	320	440	990
2050	160	440	600	1,400
NPV	730	3,400	5,400	11,000

Notes:

[a] The SC-CO_2 values are dollar-year and emissions-year specific

[b] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[694] U.S. EPA. (2012). ''Regulatory impact analysis supporting the 2012 U.S. Environmental Protection Agency final new source performance standards and amendments to the national emission standards for hazardous air pollutants for the oil and natural gas industry.'' Retrieved from *http://www.epa.gov/ttn/ecas/regdata/RIAs/oil_natural_gas_final_neshap_nsps_ria.pdf*.

[695] Source: Table 2.14 (Errata). Lifetimes, radiative efficiencies and direct (except for CH_4) GWPs relative to CO_2. IPCC Fourth Assessment Report ''Climate Change 2007: Working Group I: The Physical Science Basis.''

TABLE IX–17—ANNUAL UPSTREAM AND DOWNSTREAM N_2O BENEFITS FOR THE GIVEN SC-CO_2 VALUE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE, USING THE GWP APPROACH [a] [b]

[$Millions of 2012$] [b]

Calendar year	N_2O			
	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2018	$0.0	$0.0	$0.1	$0.2
2019	0.0	0.1	0.2	0.3
2020	0.0	0.2	0.2	0.5
2021	0.1	0.4	0.5	1.1
2022	0.2	0.6	1.0	1.9
2023	0.3	0.9	1.4	2.8
2024	0.4	1.4	2.1	4.4
2025	0.6	2.0	2.9	6.0
2026	0.8	2.6	3.7	7.8
2027	1.0	3.2	4.7	10
2028	1.2	3.9	5.7	12
2029	1.5	4.6	6.6	14
2030	1.6	5.3	7.7	16
2035	2.8	8.3	12	26
2040	3.8	11	15	34
2050	5.6	15	21	47
NPV	25	120	180	360

Notes:
[a] The SC-CO_2 values are dollar-year and emissions-year specific.
[b] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE IX–18—ANNUAL UPSTREAM AND DOWNSTREAM HFC–134A BENEFITS FOR THE GIVEN SC-CO_2 VALUE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE, USING THE GWP APPROACH [a] [b]

[$Millions of 2012$] [b]

Calendar year	HFC–134a			
	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2018	$0.0	$0.0	$0.0	$0.0
2019	0.0	0.0	0.0	0.0
2020	0.0	0.0	0.0	0.0
2021	0.2	0.8	1.3	2.6
2022	0.5	1.7	2.6	5.3
2023	0.8	2.7	4.0	8.1
2024	1.1	3.7	5.4	11
2025	1.4	4.7	6.9	14
2026	1.8	5.9	8.6	18
2027	2.2	7.1	10	22
2028	2.5	8.3	12	25
2029	3.0	10	14	29
2030	3.4	11	16	34
2035	5.2	15	22	48
2040	6.1	18	25	56
2050	8.4	23	31	71
NPV	44	200	320	630

Notes:
[a] The SC-CO_2 values are dollar-year and emissions-year specific.
[b] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(b) Non-CO_2 GHG Benefits Based on Directly Modeled Estimates

Several researchers have directly estimated the social cost of non-CO_2 emissions using integrated assessment models (IAMs), though the number of such estimates is small compared to the large number of SC-CO_2 estimates available in the literature. As discussed in previous RIAs (*e.g.,* EPA 2012), there is considerable variation among these published estimates in the models and input assumptions they employ. These studies differ in the emission perturbation year, employ a wide range of constant and variable discount rate specifications, and consider a range of baseline socioeconomic and emissions scenarios that have been developed over the last 20 years. However, none of the other published estimates of the social cost of non-CO_2 GHG are consistent with the SC-CO_2 estimates, and most are likely underestimates due to changes in the underlying science since their publication.

Recently, a paper by Marten *et al.* (2014) provided the first set of published SC-CH_4 and SC-N_2O

estimates that are consistent with the modeling assumptions underlying the SC-CO_2.[696] Specifically, the estimation approach of Marten *et al.* (2014) used the same set of three IAMs, five socioeconomic-emissions scenarios, equilibrium climate sensitivity distribution, three constant discount rates, and aggregation approach used to develop the SC-CO_2 estimates.

The resulting SC-CH_4 and SC-N_2O estimates are presented in Table IX–19. More detailed discussion of their methodology, results and a comparison to other published estimates can be found in the RIA and in Marten *et al.* (2014). The tables do not include HFC–134a because EPA is unaware of analogous estimates.

TABLE IX–19—SOCIAL COST OF CH_4 AND N_2O, 2012–2050 [a] [IN 2012$ PER METRIC TON]

[Source: Marten et al., 2014]

Year	SC-CH_4				SC-N_2O			
	5% Average	3% Average	2.5% Average	3% 95th percentile	5% Average	3% Average	2.5% Average	3% 95th percentile
2012	$440	$1,000	$1,400	$2,800	$4,000	$14,000	$20,000	$37,000
2015	500	1,200	1,500	3,100	4,400	15,000	22,000	39,000
2020	590	1,300	1,700	3,500	5,200	16,000	24,000	44,000
2025	710	1,500	19,000	4,100	6,000	18,000	27,000	50,000
2030	840	1,700	2,300	4,600	7,000	20,000	29,000	55,000
2035	990	2,000	2,500	5,400	8,100	23,000	32,000	61,000
2040	1,200	2,300	2,800	6,000	9,300	25,000	35,000	67,000
2045	1,300	2,500	3,100	6,800	11,000	27,000	38,000	73,000
2050	1,500	2,700	3,300	7,400	12,000	29,000	41,000	80,000

Note:
[a] The values are emissions-year specific and have been rounded to two significant digits. Unrounded numbers were used to calculate the GHG benefits.

The application of directly modeled estimates from Marten et al. (2014) to benefit-cost analysis of a regulatory action is analogous to the use of the SC-CO_2 estimates. Specifically, the SC-CH_4 and SC-N_2O estimates in Table IX–19 are used to monetize the benefits of changes in CH_4 and N_2O emissions expected as a result of the proposed rulemaking. Forecast changes in CH_4 and N_2O emissions in a given year resulting from the regulatory action are multiplied by the SC-CH_4 and SC-N_2O estimate for that year, respectively. To obtain a present value estimate, the monetized stream of future non-CO_2 benefits are discounted back to the analysis year using the same discount rate used to estimate the social cost of the non-CO_2 GHG emission changes.

The CH_4 and N_2O benefits based on Marten et al. (2014) are presented for each calendar year in Table IX–20. Including these benefits would increase the total net present value of the GHG benefits for this proposed rulemaking by about $1.5 billion to $12 billion (2012$), or roughly 4 to 7 percent, depending on discount rate.

TABLE IX–20—ANNUAL UPSTREAM AND DOWNSTREAM NON-CO_2 GHG BENEFITS FOR THE GIVEN SC-NON-CO_2 VALUE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE, USING THE DIRECTLY MODELED APPROACH [a b]

[Millions of 2012$] [c]

Calendar year	CH_4				N_2O			
	5% Average	3% Average	2.5% Average	3% 95th percentile	5% Average	3% Average	2.5% Average	3% 95th percentile
2018	$0.6	$1.3	$1.6	$3.3	$0.0	$0.1	$0.1	$0.2
2019	1.1	2.6	3.4	6.8	0.0	0.1	0.2	0.3
2020	1.8	3.9	5.2	10	0.1	0.2	0.3	0.5
2021	5.8	13	17	35	0.1	0.4	0.6	1.2
2022	11	24	31	65	0.3	0.8	1.1	2.1
2023	17	35	49	97	0.4	1.1	1.7	3.1
2024	26	56	72	150	0.6	1.8	2.5	4.7
2025	35	74	95	200	0.8	2.4	3.5	6.5
2026	46	99	130	260	1.0	3.0	4.5	8.4
2027	57	120	150	320	1.3	4.0	5.8	11
2028	69	140	190	390	1.6	4.8	6.9	13
2029	82	170	220	460	1.9	5.8	8.2	15
2030	95	190	260	520	2.2	6.5	9.3	18
2035	160	330	400	870	3.7	10	15	28
2040	230	430	540	1,200	5.2	14	19	37
2050	350	620	770	1,700	7.9	20	27	53
NPV	1,500	4,600	6,400	12,000	34	150	230	400

Notes:

[696] Marten, A.L., E.A. Kopits, C.W. Griffiths, S.C. Newbold & A. Wolverton (2014). Incremental CH_4 and N_2O mitigation benefits consistent with the U.S. Government's SC-CO_2 estimates, *Climate Policy,* DOI: 10.1080/14693062.2014.912981.

[a] The SC-CH4 and SC-N_2O values are dollar-year and emissions-year specific.

[b] Note that net present discounted values of reduced GHG emissions is are calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SC-CH4 and SC-N_2O at 5, 3, and 2.5 percent) is used to calculate net present value discounted values of SC-CH4 and SC-N_2O for internal consistency. Refer to SCC TSD for more detail.

[c] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

As illustrated above, compared to the use of directly modeled estimates the GWP-based approximation approach underestimates the climate benefits of the CH_4 emission reductions by 12 percent to 52 percent and the climate benefits of N_2O reductions by 10 percent to 26 percent, depending on the discount rate assumption.

(c) Additional Non-CO_2 GHGs Co-Benefits

In determining the relative social costs of the different gases, the Marten et al. (2014) analysis accounts for differences in lifetime and radiative efficiency between the non-CO_2 GHGs and CO_2. The analysis also accounts for radiative forcing resulting from methane's effects on tropospheric ozone and stratospheric water vapor, and for at least some of the fertilization effects of elevated carbon dioxide concentrations. However, there exist several other differences between these gases that have not yet been captured in this analysis, namely the non-radiative effects of methane-driven elevated tropospheric ozone levels on human health, agriculture, and ecosystems, and the effects of carbon dioxide on ocean acidification. Inclusion of these additional non-radiative effects would potentially change both the absolute and relative value of the various gases.

Of these effects, the human health effect of elevated tropospheric ozone levels resulting from methane emissions is the closest to being monetized in a way that would be comparable to the SCC. Premature ozone-related cardiopulmonary deaths resulting from global increases in tropospheric ozone concentrations produced by the methane oxidation process have been the focus of a number of studies over the past decade (*e.g.,* West *et al.* 2006 [697]). Recent studies have produced an estimate of a monetized benefit of methane emissions reductions, with results on the order of $1,000 per metric ton of CH_4 emissions reduced (Anenberg *et al.* 2012 [698]; Shindell *et al.* 2012 [699]), an estimate similar in magnitude to the climate benefits of CH_4 reductions estimated by the Marten *et al.* or GWP methods. However, though EPA is continuing to monitor this area of research as it evolves, EPA is not applying them for benefit estimates at this time.

H. Monetized Non-GHG Health Impacts

This section analyzes the economic benefits from reductions in health and environmental impacts resulting from non-GHG emission reductions that can be expected to occur as a result of the proposed Phase 2 standards. CO_2 emissions are predominantly the byproduct of fossil fuel combustion processes that also produce criteria and hazardous air pollutant emissions. The vehicles that are subject to the proposed standards are also significant sources of mobile source air pollution such as direct PM, NO_X, VOCs and air toxics. The proposed standards would affect exhaust emissions of these pollutants from vehicles and would also affect emissions from upstream sources that occur during the refining and distribution of fuel. Changes in ambient concentrations of ozone, $PM_{2.5}$, and air toxics that would result from the proposed standards are expected to affect human health by reducing premature deaths and other serious human health effects, as well as other important improvements in public health and welfare.

It is important to quantify the health and environmental impacts associated with the proposed standards because a failure to adequately consider these ancillary impacts could lead to an incorrect assessment of their costs and benefits. Moreover, the health and other impacts of exposure to criteria air pollutants and airborne toxics tend to occur in the near term, while most effects from reduced climate change are likely to occur only over a time frame of several decades or longer.

Although EPA typically quantifies and monetizes the health and environmental impacts related to both PM and ozone in its regulatory impact analyses (RIAs), it was unable to do so in time for this proposal. Instead, EPA has applied PM-related "benefits per-ton" values to its estimated emission reductions as an interim approach to estimating the PM-related benefits of the proposal. [700] [701] EPA also characterizes the health and environmental impacts that will be quantified and monetized for the final rulemaking.

This section is split into two sub-sections: the first presents the benefits-per-ton values used to monetize the benefits from reducing population exposure to PM associated with the proposed standards; the second explains what PM- and ozone-related health and environmental impacts EPA will quantify and monetize in the analysis for the final rule. EPA bases its analyses on peer-reviewed studies of air quality and health and welfare effects and peer-reviewed studies of the monetary values of public health and welfare improvements, and is generally consistent with benefits analyses performed for the analysis of the final Tier 3 Vehicle Rule,[702] the final 2012 p.m. NAAQS Revision,[703] and the final

[697] West JJ, Fiore AM, Horowitz LW, Mauzerall DL (2006) Global health benefits of mitigating ozone pollution with methane emission controls. Proc Natl Acad Sci USA 103(11):3988–3993. doi:10.1073/pnas.0600201103.

[698] Anenberg SC, Schwartz J, Shindell D, Amann M, Faluvegi G, Klimont Z, . . ., Vignati E (2012) Global air quality and health co-benefits of mitigating near-term climate change through methane and black carbon emission controls. Environ Health Perspect 120(6):831. doi:10.1289/ehp.1104301.

[699] Shindell D, Kuylenstierna JCI, Vignati E, van Dingenen R, Amann M, Klimont Z, . . . , Fowler D (2012) Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security. Science 335 (6065):183–189. doi:10.1126/science.1210026.

[700] Fann, N., Baker, K.R., and Fulcher, C.M. (2012). *Characterizing the $PM_{2.5}$-related health benefits of emission reductions for 17 industrial, area and mobile emission sectors across the U.S.,* Environment International, 49, 241–151, published online September 28, 2012.

[701] See also: *http://www.epa.gov/airquality/benmap/sabpt.html.* The current values available on the Web page have been updated since the publication of the Fann et al., 2012 paper. For more information regarding the updated values, see: *http://www.epa.gov/airquality/benmap/models/Source_Apportionment_BPT_TSD_1_31_13.pdf* (accessed September 9, 2014).

[702] U.S. Environmental Protection Agency. (2014). *Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards Final Rule: Regulatory Impact Analysis,* Assessment and Standards Division, Office of Transportation and Air Quality, EPA–420–R–14–005, March 2014. Available on the Internet: *http://www.epa.gov/otaq/documents/tier3/420r14005.pdf.*

[703] U.S. Environmental Protection Agency. (2012). *Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter,* Health and Environmental Impacts Division, Office of Air Quality Planning and Standards, EPA–452–R–12–005, December 2012. Available on the Internet: *http://www.epa.gov/ttnecas1/regdata/RIAs/finalria.pdf.*

2017–2025 Light Duty Vehicle GHG Rule.[704]

Though EPA is characterizing the changes in emissions associated with toxic pollutants, we are not able to quantify or monetize the human health effects associated with air toxic pollutants for either the proposal or the final rule analyses (see Section VIII.G.1.b.iii for more information). Please refer to Section VIII for more information about the air toxics emissions impacts associated with the proposed standards.

(1) Economic Value of Reductions in Criteria Pollutants

As described in Section VIII, the proposed standards would reduce emissions of several criteria and toxic pollutants and their precursors. In this analysis, EPA estimates the economic value of the human health benefits associated with the resulting reductions in $PM_{2.5}$ exposure. Due to analytical limitations with the benefit per ton method, this analysis does not estimate benefits resulting from reductions in population exposure to other criteria pollutants such as ozone.[705] Furthermore, the benefits per-ton method, like all air quality impact analyses, does not monetize all of the potential health and welfare effects associated with reduced concentrations of $PM_{2.5}$.

This analysis uses estimates of the benefits from reducing the incidence of the specific $PM_{2.5}$-related health impacts described below. These estimates, which are expressed per ton of $PM_{2.5}$-related emissions eliminated by the proposed rules, represent the monetized value of human health benefits (including reductions in both premature mortality and premature morbidity) from reducing each ton of directly emitted $PM_{2.5}$ or its precursors (SO_2 and NO_X), from a specified source. Ideally, the human health benefits would be estimated based on changes in ambient $PM_{2.5}$ as determined by full-scale air quality modeling. However, the length of time needed to prepare the necessary emissions inventories, in addition to the processing time associated with the modeling itself, has precluded us from performing air quality modeling for this proposal. We will conduct this modeling for the final rule.

The dollar-per-ton estimates used in this analysis are provided in Table IX–21. As the table indicates, these values differ among pollutants, and also depend on their original source, because emissions from different sources can result in different degrees of population exposure and resulting health impacts. In the summary of costs and benefits, Section IX.K of this preamble, EPA presents the monetized value of PM-related improvements associated with the proposal.

TABLE IX–21—BENEFITS-PER-TON VALUES

[Thousands, 2012$] [a]

Year [c]	On-road mobile sources			Upstream sources [d]		
	Direct $PM_{2.5}$	SO_2	NO_X	Direct $PM_{2.5}$	SO_2	NO_X
Estimated Using a 3 Percent Discount Rate [b]						
2016	$380–$850	$20–$45	$7.7–$18	$330–$750	$69–$160	$6.8–$16
2020	400–910	22–49	8.1–18	350–790	75–170	7.4–17
2025	440–1,000	24–55	8.8–20	390–870	83–190	8.1–18
2030	480–1,100	27–61	9.6–22	420–950	91–200	8.7–20
Estimated Using a 7 Percent Discount Rate [b]						
2016	$340–$770	$18–$41	$6.9–$16	$290–$670	$63–$140	$6.2–$14
2020	370–820	20–44	7.4–17	320–720	67–150	6.6–15
2025	400–910	22–49	8.0–18	350–790	75–170	7.3–17
2030	430–980	24–55	8.6–20	380–850	81–180	7.9–18

Notes:

[a] The benefit-per-ton estimates presented in this table are based on a range of premature mortality estimates derived from the ACS study (Krewski et al., 2009) and the Six-Cities study (Lepeule et al., 2012). See Chapter VIII of the RIA for a description of these studies.

[b] The benefit-per-ton estimates presented in this table assume either a 3 percent or 7 percent discount rate in the valuation of premature mortality to account for a twenty-year segmented premature mortality cessation lag.

[c] Benefit-per-ton values were estimated for the years 2016, 2020, 2025 and 2030. We hold values constant for intervening years (*e.g.,* the 2016 values are assumed to apply to years 2017–2019; 2020 values for years 2021–2024; 2030 values for years 2031 and beyond).

[d] We assume for the purpose of this analysis that total "upstream emissions" are most appropriately monetized using the refinery sector benefit per-ton values. The majority of upstream emission reductions associated with the proposed rule are related to domestic onsite refinery emissions and domestic crude production. While total upstream emissions also include storage and transport sources, as well as sources upstream from the refinery, we have chosen to simply apply the refinery values. Full-scale air quality modeling, and the associated benefits analysis, will include upstream emissions from all sources in the FRM.

The benefit-per-ton technique has been used in previous analyses, including EPA's 2017–2025 Light-Duty Vehicle Greenhouse Gas Rule,[706] the Reciprocating Internal Combustion Engine rules,[707 708] and the Residential

[704] U.S. Environmental Protection Agency (U.S. EPA). (2012). *Regulatory Impact Analysis: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards,* Assessment and Standards Division, Office of Transportation and Air Quality, EPA–420–R–12–016, August 2012. Available on the Internet at: *http://www.epa.gov/otaq/climate/documents/420r12016.pdf.*

[705] The air quality modeling that underlies the PM-related benefit per ton values also produced estimates of ozone levels attributable to each sector. However, the complex non-linear chemistry governing ozone formation prevented EPA from developing a complementary array of ozone benefit per ton values. This limitation notwithstanding, we anticipate that the ozone-related benefits associated with reducing emissions of NO_X and VOC could be substantial.

[706] U.S. Environmental Protection Agency (U.S. EPA). (2012). *Regulatory Impact Analysis: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards,* Assessment and Standards Division, Office of Transportation and Air Quality, EPA–420–R–12–016, August 2012. Available on the Internet at: *http://www.epa.gov/otaq/climate/documents/420r12016.pdf.*

[707] U.S. Environmental Protection Agency (U.S. EPA). (2013). *Regulatory Impact Analysis for the*

Continued

Wood Heaters NSPS.[709] Table IX–22 shows the quantified $PM_{2.5}$-related co-benefits captured in those benefit per-ton estimates, as well as unquantified effects the benefit per-ton estimates are unable to capture.

TABLE IX–22—HUMAN HEALTH AND WELFARE EFFECTS OF $PM_{2.5}$

Pollutant/effect	Quantified and monetized in primary estimates	Unquantified effects Changes in:
$PM_{2.5}$	Adult premature mortality	Chronic and subchronic bronchitis cases.
	Acute bronchitis	Strokes and cerebrovascular disease.
	Hospital admissions: Respiratory and cardiovascular	Low birth weight.
		Pulmonary function.
	Emergency room visits for asthma	Chronic respiratory diseases other than chronic bronchitis.
	Nonfatal heart attacks (myocardial infarction)	Non-asthma respiratory emergency room visits.
	Lower and upper respiratory illness	Visibility.
	Minor restricted-activity days	Household soiling.
	Work loss days.	
	Asthma exacerbations (asthmatic population).	
	Infant mortality.	

A more detailed description of the benefit-per-ton estimates is provided in Chapter VIII of the Draft RIA that accompanies this rulemaking. Readers interested in reviewing the complete methodology for creating the benefit-per-ton estimates used in this analysis can consult EPA's ''Technical Support Document: Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 17 Sectors.'' [710] Readers can also refer to Fann et al. (2012) [711] for a detailed description of the benefit-per-ton methodology.

As Table IX–20 indicates, EPA projects that the per-ton values for reducing emissions of non-GHG pollutants from both vehicle use and upstream sources such as fuel refineries will increase over time.[712] These projected increases reflect rising income levels, which increase affected individuals' willingness to pay for reduced exposure to health threats from air pollution.[713] They also reflect future population growth and increased life expectancy, which expands the size of the population exposed to air pollution in both urban and rural areas, especially among older age groups with the highest mortality risk.[714]

(2) Human Health and Environmental Benefits for the Final Rule

(a) Human Health and Environmental Impacts

To model the ozone and PM air quality benefits of the final rule, EPA will use the Community Multiscale Air Quality (CMAQ) model (see Section VIII for a description of the CMAQ model). The modeled ambient air quality data will serve as an input to the Environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP CE).[715] BenMAP CE is a computer program developed by EPA that integrates a number of the modeling elements used in previous RIAs (*e.g.,* interpolation functions, population projections, health impact functions, valuation functions, analysis and pooling methods) to translate modeled air concentration estimates into health effects incidence estimates and monetized benefits estimates.

Chapter VIII in the DRIA that accompanies this proposal lists the co-pollutant health effect concentration-response functions EPA will use to quantify the non-GHG incidence impacts associated with the proposed heavy-duty vehicle standards. These include PM- and ozone-related premature mortality, nonfatal heart attacks, hospital admissions (respiratory and cardiovascular), emergency room visits, acute bronchitis, minor restricted activity days, and days of work and school lost.

(b) Monetized Impacts

To calculate the total monetized impacts associated with quantified health impacts, EPA applies values derived from a number of sources. For premature mortality, EPA applies a value of a statistical life (VSL) derived from the mortality valuation literature. For certain health impacts, such as a number of respiratory-related ailments, EPA applies willingness-to-pay estimates derived from the valuation literature. For the remaining health impacts, EPA applies values derived from current cost-of-illness and/or wage estimates. Chapter VIII in the DRIA that accompanies this proposal presents the monetary values EPA will apply to changes in the incidence of health and welfare effects associated with reductions in non-GHG pollutants that will occur when these GHG control strategies are finalized.

Reconsideration of the Existing Stationary Compression Ignition (CI) Engines NESHAP, Office of Air Quality Planning and Standards, Research Triangle Park, NC. January. EPA–452/R–13–001. Available at <*http://www.epa.gov/ttnecas1/regdata/RIAs/RICE_NESHAPreconsideration_Compression_Ignition_Engines_RIA_final2013_EPA.pdf*>.

[708] U.S. Environmental Protection Agency (U.S. EPA). (2013). *Regulatory Impact Analysis for Reconsideration of Existing Stationary Spark Ignition (SI) RICE NESHAP,* Office of Air Quality Planning and Standards, Research Triangle Park, NC. January. EPA–452/R–13–002. Available at <*http://www.epa.gov/ttnecas1/regdata/RIAs/NESHAP_RICE_Spark_Ignition_RIA_finalreconsideration2013_EPA.pdf*>.

[709] U.S. Environmental Protection Agency (U.S. EPA). (2015). *Regulatory Impact Analysis for Residential Wood Heaters NSPS Revision.* Office of Air Quality Planning and Standards, Research Triangle Park, NC. February. EPA–452/R–15–001. Available at <*http://www2.epa.gov/sites/production/files/2015-02/documents/20150204-residential-wood-heaters-ria.pdf*>.

[710] For more information regarding the updated values, see: *http://www.epa.gov/airquality/benmap/models/Source_Apportionment_BPT_TSD_1_31_13.pdf* (accessed September 9, 2014).

[711] Fann, N., Baker, K.R., and Fulcher, C.M. (2012). *Characterizing the $PM_{2.5}$-related health benefits of emission reductions for 17 industrial, area and mobile emission sectors across the U.S.,* Environment International, 49, 241–151, published online September 28, 2012.

[712] As we discuss in the emissions chapter of the DRIA (Chapter V), the rule would yield emission reductions from upstream refining and fuel distribution due to decreased petroleum consumption.

[713] The issue is discussed in more detail in the 2012 p.m. NAAQS RIA, Section 5.6.8. See U.S. Environmental Protection Agency. (2012). *Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter,* Health and Environmental Impacts Division, Office of Air Quality Planning and Standards, EPA–452–R–12–005, December 2012. Available on the internet: *http://www.epa.gov/ttnecas1/regdata/RIAs/finalria.pdf.*

[714] For more information about EPA's population projections, please refer to the following: *http://www.epa.gov/air/benmap/models/BenMAPManualAppendicesAugust2010.pdf* (See Appendix K).

[715] Information on BenMAP, including downloads of the software, can be found at *http://www.epa.gov/air/benmap/.*

(c) Other Unquantified Health and Environmental Impacts

In addition to the co-pollutant health and environmental impacts EPA will quantify for the analysis of the final standard, there are a number of other health and human welfare endpoints that EPA will not be able to quantify or monetize because of current limitations in the methods or available data. These impacts are associated with emissions of air toxics (including benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, naphthalene and ethanol), ambient ozone, and ambient $PM_{2.5}$ exposures. Chapter VIII of the DRIA lists these unquantified health and environmental impacts.

While there will be impacts associated with air toxic pollutant emission changes that result from the final standard, EPA will not attempt to monetize those impacts. This is primarily because currently available tools and methods to assess air toxics risk from mobile sources at the national scale are not adequate for extrapolation to incidence estimations or benefits assessment. The best suite of tools and methods currently available for assessment at the national scale are those used in the National-Scale Air Toxics Assessment (NATA). EPA's Science Advisory Board specifically commented in their review of the 1996 NATA that these tools were not yet ready for use in a national-scale benefits analysis, because they did not consider the full distribution of exposure and risk, or address sub-chronic health effects.[716] While EPA has since improved the tools, there remain critical limitations for estimating incidence and assessing benefits of reducing mobile source air toxics.[717] EPA continues to work to address these limitations; however, EPA does not anticipate having methods and tools available for national-scale application in time for the analysis of the final rules.[718]

[716] Science Advisory Board. 2001. NATA—Evaluating the National-Scale Air Toxics Assessment for 1996—an SAB Advisory. *http://www.epa.gov/ttn/atw/sab/sabrev.html*.

[717] Examples include gaps in toxicological data, uncertainties in extrapolating results from high-dose animal experiments to estimate human effects at lower does, limited ambient and personal exposure monitoring data, and insufficient economic research to support valuation of the health impacts often associated with exposure to individual air toxics. See Gwinn et al., 2011. Meeting Report: Estimating the Benefits of Reducing Hazardous Air Pollutants—Summary of 2009 Workshop and Future Considerations. Environ Health Perspect. Jan 2011; 119(1): 125–130.

[718] In April, 2009, EPA hosted a workshop on estimating the benefits of reducing hazardous air pollutants. This workshop built upon the work accomplished in the June 2000 in an earlier (2000) Science Advisory Board/EPA Workshop on the Benefits of Reductions in Exposure to Hazardous Air Pollutants, which generated thoughtful discussion on approaches to estimating human health benefits from reductions in air toxics exposure, but no consensus was reached on methods that could be implemented in the near term for a broad selection of air toxics. Please visit *http://epa.gov/air/toxicair/2009workshop.html* for more information about the workshop and its associated materials.

I. Energy Security Impacts

The Phase 2 standards are designed to require improvements in the fuel efficiency of medium- and heavy-duty vehicles and, thereby, reduce fuel consumption and GHG emissions. In turn, the Phase 2 standards help to reduce U.S. petroleum imports. A reduction of U.S. petroleum imports reduces both financial and strategic risks caused by potential sudden disruptions in the supply of imported petroleum to the U.S., thus increasing U.S. energy security. This section summarizes the agency's estimates of U.S. oil import reductions and energy security benefits of the proposed Phase 2 standards. Additional discussion of this issue can be found in Chapter 8 of the draft RIA.

(1) Implications of Reduced Petroleum Use on U.S. Imports

U.S. energy security is broadly defined as the continued availability of energy sources at an acceptable price. Most discussion of U.S. energy security revolves around the topic of the economic costs of U.S. dependence on oil imports. However, it is not imports alone, but both imports and consumption of petroleum from all sources and their role in economic activity, that expose the U.S. to risk from price shocks in the world oil price. The relative significance of petroleum consumption and import levels for the macroeconomic disturbances that follow from oil price shocks is not fully understood. Recognizing that changing petroleum consumption will change U.S. imports, this assessment of oil costs focuses on those incremental social costs that follow from the resulting changes in imports, employing the usual oil import premium measure. The agencies request comment on how to incorporate the impact of changes in oil consumption, rather than imports exclusively, into our energy security analysis.

While the U.S. has reduced its consumption and increased its production of oil in recent years, it still relies on oil from potentially unstable sources. In addition, oil exporters with a large share of global production have the ability to raise the price of oil by exerting the monopoly power associated with a cartel, the Organization of Petroleum Exporting Countries (OPEC), to restrict oil supply relative to demand. These factors contribute to the vulnerability of the U.S. economy to episodic oil supply shocks and price spikes. In 2012, U.S. net expenditures for imports of crude oil and petroleum products were $290 billion and expenditures on both imported oil and domestic petroleum and refined products totaled $634 billion (see Figure IX–1).[719] Import costs have declined since 2011 but total oil expenditures (domestic and imported) remain near historical highs, at roughly triple the inflation-adjusted levels experienced by the U.S. from 1986 to 2002.

In 2010, just over 40 percent of world oil supply came from OPEC nations and the AEO 2014 (Early Release)[720] projects that this share will rise gradually to over 45 percent by 2040. Approximately 31 percent of global supply is from Middle East and North African countries alone, a share that is also expected to grow. Measured in terms of the share of world oil resources or the share of global oil export supply, rather than oil production, the concentration of global petroleum resources in OPEC nations is even larger. As another measure of concentration, of the 137 countries/principalities that export either crude or refined products, the top 12 have recently accounted for over 55 percent of exports.[721] Eight of these countries are members of OPEC, and a ninth is Russia.[722] In a market where even a 1–2 percent supply loss can raise prices noticeably, and where a 10 percent supply loss could lead to an unprecedented price shock, this regional concentration is of concern.[723]

[719] See EIA Annual Energy Review, various editions. For data 2011–2013, and projected data: EIA Annual Energy Outlook (AEO) 2014 (Reference Case). See Table 11, file ''aeotab_11.xls.''

[720] The agencies used the AEO 2014 (Early Release) since this version of AEO was available at the time that fuel savings from the rule were being estimated. The AEO 2014 (Early Release) and the AEO 2014 have very similar energy market and economic projections. For example, world oil prices are the same between the two forecasts.

[721] Based on data from the CIA, combining various recent years, *https://www.cia.gov/library/publications/the-world-factbook/rankorder/2242rank.html.*

[722] The other three are Norway, Canada, and the EU, an exporter of product.

[723] For example, the 2005 Hurricanes Katrina/Rita and the 2011 Libyan conflict both led to a 1.8 percent reduction in global crude supply. While the price impact of the latter is not easily distinguished given the rapidly rising post-recession prices, the former event was associated with a 10–15 percent world oil price increase. There are a range of smaller events with smaller but noticeable impacts. Somewhat larger events, such as the 2002/3 Venezuelan Strike and the War in Iraq,

Continued

Historically, the countries of the Middle East have been the source of eight of the ten major world oil disruptions,[724] with the ninth originating in Venezuela, an OPEC country, and the tenth being Hurricanes Katrina and Rita.

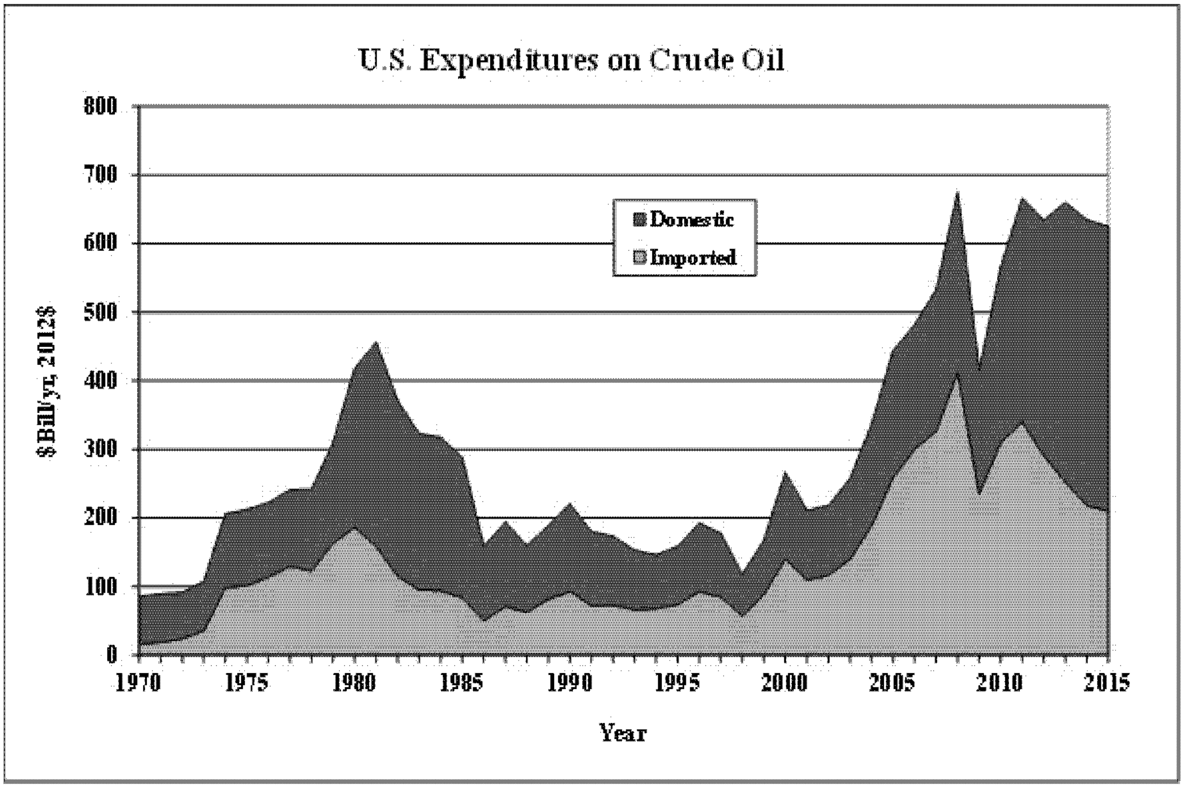

Figure IX-1 U.S. Expenditures on Crude Oil from 1970 through 2015[725]

The agencies used EPA's MOVES model to estimate the reductions in U.S. fuel consumption due to this proposed rule for vocational vehicles and tractors. For HD pickups and vans, the agencies used both DOT's CAFE model and EPA's MOVES model to estimate the fuel consumption impacts. (Detailed explanations of the MOVES and CAFE models can be found in Chapters 5 and 10 of the draft RIA. See IX.C of the preamble for estimates of reduced fuel consumption from the proposed rule). Based on a detailed analysis of differences in U.S. fuel consumption, petroleum imports, and imports of petroleum products, the agencies estimate that approximately 90 percent of the reduction in fuel consumption resulting from adopting improved GHG emission standards and fuel efficiency standards is likely to be reflected in reduced U.S. imports of crude oil and net imported petroleum products.[726] Thus, on balance, each gallon of fuel saved as a consequence of the HD GHG and fuel efficiency standards is anticipated to reduce total U.S. imports of petroleum by 0.90 gallons.[727] Based upon the fuel savings estimated by the MOVES/CAFE models and the 90 percent oil import factor, the reduction in U.S. oil imports from these proposed rules are estimated for the years 2020, 2025, 2030, 2040, and 2050 (in millions of barrels per day (MMBD)) in Table IX–25 below. For comparison purposes, Table IX–25 also shows U.S. imports of crude oil in 2020, 2025, 2030 and 2040 as projected by DOE in the Annual Energy Outlook 2014 (Early Release) Reference Case. U.S. Gross Domestic

corresponded to about a 2.9 percent sustained loss of supply, and was associated with a 28 percent world oil price increase.

[724] IEA 2011 "IEA Response System for Oil Supply Emergencies."

[725] For historical data: EIA Annual Energy Review, various editions. For data 2011–2013, and projected data: EIA Annual Energy Outlook (AEO) 2014 (Reference Case). See Table 11, file "aeotab_ 11.xls".

[726] We looked at changes in crude oil imports and net petroleum products in the Reference Case in comparison to two cases from the AEO 2014. The two cases are the Low (*i.e.,* Economic Growth) Demand and Low VMT cases. See the spreadsheet "Impacts on Fuel Demands and ImportsJan9.xlsx" comparing the AEO 2014 Reference Case to the Low Demand Case. See the spreadsheet "Impact of Fuel Demand and Impacts January20VMT.xlsl" for a comparison of AEO 2014 Reference Case and the Low VMT Case. We also considered a paper entitled "Effect of a U.S. Demand Reduction on Imports and Domestic Supply Levels" by Paul Leiby, 4/16/2013. This paper suggests that "Given a particular reduction in oil demand stemming from a policy or significant technology change, the fraction of oil use savings that shows up as reduced U.S. imports, rather than reduced U.S. supply, is actually quite close to 90 percent, and probably close to 95 percent".

[727] The NHTSA analysis uses a slightly different value that was estimated using unique runs of the National Energy Modeling System (NEMS) that forms the foundation of the Annual Energy Outlook. NHTSA ran a version of NEMS from 2012 (which would have been used in the 2013 AEO) and computed the change in imports of petroleum products with and without the Phase 1 MDHD program to estimate the relationship between changes in fuel consumption and oil imports. The analysis found that reducing gasoline consumption by 1 gallon reduces imports of refined gasoline by 0.06 gallons and domestic refining from imported crude by 0.94 gallons. Similarly, one gallon of diesel saved by the Phase 1 rule was estimated to reduce imports of refined diesel by 0.26 gallons and domestic refining of imported crude by 0.74 gallons. The agencies will update this analysis for the Final Rule using the model associated with AEO2014, modeling the Phase 2 Preferred Alternative explicitly.

Product (GDP) is projected to grow by roughly 59 percent over the same time frame (*e.g.,* from 2020 to 2040) in the same AEO projections.

TABLE IX–23—PROJECTED U.S. IMPORTS OF CRUDE OIL AND U.S. OIL IMPORT REDUCTIONS RESULTING FROM THE PROPOSED PHASE 2 HEAVY-DUTY VEHICLE RULE IN 2020, 2025, 2030, 2040 AND 2050 USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of barrels per day (MMBD)] [a]

Year	U.S. oil imports	Reductions from proposed HD rule
2020	4.93	0.01
2025	5.04	0.16
2030	5.35	0.37
2040	5.92	0.65
2050	*	0.78

Notes:

* The AEO 2014 (Early Release) only projects energy market and economic trends through 2040.

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(2) Energy Security Implications

In order to understand the energy security implications of reducing U.S. oil imports, EPA has worked with Oak Ridge National Laboratory (ORNL), which has developed approaches for evaluating the social costs and energy security implications of oil use. The energy security estimates provided below are based upon a methodology developed in a peer-reviewed study entitled, ''*The Energy Security Benefits of Reduced Oil Use, 2006–2015,*'' completed in March 2008. This ORNL study is an updated version of the approach used for estimating the energy security benefits of U.S. oil import reductions developed in a 1997 ORNL Report.[728] For EPA and NHTSA rulemakings, the ORNL methodology is updated periodically to account for forecasts of future energy market and economic trends reported in the U.S. Energy Information Administration's Annual Energy Outlook.

When conducting this analysis, ORNL considered the full cost of importing petroleum into the U.S. The full economic cost is defined to include two components in addition to the purchase price of petroleum itself. These are: (1) The higher costs for oil imports resulting from the effect of U.S. demand on the world oil price (*i.e.,* the ''demand'' or ''monopsony'' costs); and (2) the risk of reductions in U.S. economic output and disruption to the U.S. economy caused by sudden disruptions in the supply of imported oil to the U.S. (*i.e.,* macroeconomic disruption/adjustment costs).

The literature on the energy security for the last two decades has routinely combined the monopsony and the macroeconomic disruption components when calculating the total value of the energy security premium. However, in the context of using a global value for the Social Cost of Carbon (SCC) the question arises: How should the energy security premium be used when some benefits from the rule, such as the benefits of reducing greenhouse gas emissions, are calculated from a global perspective? Monopsony benefits represent avoided payments by U.S. consumers to oil producers that result from a decrease in the world oil price as the U.S. decreases its demand for oil. Although there is clearly an overall benefit to the U.S. when considered from a domestic perspective, the decrease in price due to decreased demand in the U.S. also represents a loss to oil producing countries, one of which is the United States. Given the redistributive nature of this monopsony effect from a global perspective, and the fact that an increasing fraction of it represents a transfer between U.S. consumers and producers, it is excluded in the energy security benefits calculations for these proposed rules.

In contrast, the other portion of the energy security premium, the avoided U.S. macroeconomic disruption and adjustment cost that arises from reductions in U.S. petroleum imports, does not have offsetting impacts outside of the U.S., and, thus, is included in the energy security benefits estimated for these proposed rules. To summarize, the agencies have included only the avoided macroeconomic disruption portion of the energy security benefits to estimate the monetary value of the total energy security benefits of these proposed rules.

For this rulemaking, ORNL updated the energy security premiums by incorporating the most recent oil price forecast and energy market trends, particularly regional oil supplies and demands, from the AEO 2014 (Early Release) into its model.[729] ORNL developed energy security premium estimates for a number of different years. Table IX–24 provides estimates for energy security premiums for the years 2020, 2025, 2030 and 2040,[730] as well as a breakdown of the components of the energy security premiums for each year. The components of the energy security premiums and their values are discussed below.

[728] Leiby, Paul N., Donald W. Jones, T. Randall Curlee, and Russell Lee, *Oil Imports: An Assessment of Benefits and Costs,* ORNL–6851, Oak Ridge National Laboratory, November, 1997.

[729] Leiby, P., Factors Influencing Estimate of Energy Security Premium for Heavy-Duty Phase 2 Proposed Rule, 11/1/2014, Oak Ridge National Laboratory.

[730] AEO 2014 (Early Release) forecasts energy market trends and values only to 2040. The post-2040 energy security premium values are assumed to be equal to the 2040 estimate.

TABLE IX–24—ENERGY SECURITY PREMIUMS IN 2020, 2025, 2030 AND 2040

[2012$/Barrel] *

Year (range)	Monopsony (range)	Avoided macro-economic disruption/adjustment costs (range)	Total mid-point (range)
2020	$4.91 (1.63–9.15)	$6.35 (3.07–10.15)	$11.25 (6.67–16.53)
2025	$5.46 (1.81–10.47)	$7.29 (3.57–11.67)	$12.75 (7.58–18.65)
2030	$6.04 (2.00–11.67)	$8.39 (4.12–13.41)	$14.43 (8.54–21.13)
2040	$7.17 (2.32–14.03)	$10.74 (5.36–17.22)	$17.91 –26.14)

Note:

* Top values in each cell are the midpoints, the values in parentheses are the 90 percent confidence intervals.

(a) Effect of Oil Use on the Long-Run Oil Price

The first component of the full economic costs of importing petroleum into the U.S. follows from the effect of U.S. import demand on the world oil price over the long-run. Because the U.S. is a sufficiently large purchaser of global oil supplies, its purchases can affect the world oil price. This monopsony power means that increases in U.S. petroleum demand can cause the world price of crude oil to rise, and conversely, that reduced U.S. petroleum demand can reduce the world price of crude oil. Thus, one benefit of decreasing U.S. oil purchases, due to improvements in the fuel efficiency of medium- and heavy-duty vehicles, is the potential decrease in the crude oil price paid for all crude oil purchased.

A variety of oil market and economic factors have contributed to lowering the estimated monopsony premium compared to monopsony premiums cited in recent EPA/NHTSA rulemakings. Three principal factors contribute to lowering the monopsony premium: Lower world oil prices, lower U.S. oil imports and less responsiveness of world oil prices to changes in U.S. oil demand. For example, between 2012 (using the AEO 2012 (Early Release)) and 2014 (using the AEO 2014 (Early Release)), there has been a general downward revision in world oil price projections in the near term (*e.g.* 19 percent in 2020) and a sharp reduction in projected U.S. oil imports in the near term, due to increased U.S. supply (*i.e.,* a 41 percent reduction in U.S. oil imports by 2017 and a 36 percent reduction in 2020). Over the longer term, oil's share of total U.S. imports is projected to gradually increase after 2020 but still remain 27 percent below the AEO2012 (Early Release) projected level in 2035.

Another factor influencing the monopsony premium is that U.S. demand on the global oil market is projected to decline, suggesting diminished overall influence and some reduction in the influence of U.S. oil demand on the world price of oil. Outside of the U.S., projected OPEC supply remains roughly steady as a share of world oil supply compared to the AEO2012 (Early Release). OPEC's share of world oil supply *outside* of the U.S. actually increases slightly. Since OPEC supply is estimated to be more price sensitive than non-OPEC supply, this means that under AEO2014 (Early Release) world oil supply is slightly more responsive to changes in U.S. oil demand. Together, these factors suggest that changes in U.S. oil import reductions have a somewhat smaller effect on the long-run world oil price than changes based on 2012 estimates.

These changes in oil price and import levels lower the monopsony portion of energy security premium since this portion of the security premium is related to the change in total U.S. oil import costs that is achieved by a marginal reduction in U.S oil imports. Since both the price and the quantity of oil imports are lower, the monopsony premium component is 46–57 percent lower over the years 2017–2025 than the estimates based upon the AEO 2012 (Early Release) projections.

There is disagreement in the literature about the magnitude of the monopsony component, and its relevance for policy analysis. Brown and Huntington (2013),[731] for example, argue that the United States' refusal to exercise its market power to reduce the world oil price does not represent a proper externality, and that the monopsony component should not be considered in calculations of the energy security externality. However, they also note in their earlier discussion paper (Brown and Huntington 2010) [732] that this is a departure from the traditional energy security literature, which includes sustained wealth transfers associated with stable but higher-price oil markets. On the other hand, Greene (2010) [733] and others in prior literature (*e.g.,* Toman 1993) [734] have emphasized that the monopsony cost component is policy-relevant because the world oil market is non-competitive and strongly influenced by cartelized and government-controlled supply decisions. Thus, while sometimes couched as an externality, Greene notes that the monopsony component is best viewed as stemming from a completely different market failure than an externality (Ledyard 2008),[735] yet still implying marginal social costs to importers.

There is also a question about the ability of gradual, long-term reductions, such as those resulting from this proposed rule, to reduce the world oil price in the presence of OPEC's monopoly power. OPEC is currently the world's marginal petroleum supplier, and could conceivably respond to gradual reductions in U.S. demand with gradual reductions in supply over the course of several years as the fuel

[731] Brown, Stephen P.A. and Hillard G. Huntington. 2013. Assessing the U.S. Oil Security Premium. Energy Economics, vol. 38, pp 118–127.

[732] Reassessing the Oil Security Premium. RFF Discussion Paper Series, (RFF DP 10–05). doi: RFF DP 10–05

[733] Greene, D.L. 2010. Measuring energy security: Can the United States achieve oil independence? Energy Policy, 38(4), 1614–1621. doi:10.1016/j.enpol.2009.01.041.

[734] Reassessing the Oil Security Premium. RFF Discussion Paper Series, (RFF DP 10–05). doi:RFF DP 10–05.

[735] Ledyard, John O. ''Market Failure.'' The New Palgrave Dictionary of Economics. Second Edition. Eds. Steven N. Durlauf and Lawrence E. Blume. Palgrave Macmillan, 2008.

savings resulting from this rule grow. However, if OPEC opts for a long-term strategy to preserve its market share, rather than maintain a particular price level (as they have done recently in response to increasing U.S. petroleum production), reduced demand would create downward pressure on the global price. The Oak Ridge analysis assumes that OPEC does respond to demand reductions over the long run, but there is still a price effect in the model. Under the mid-case behavioral assumption used in the premium calculations, OPEC responds by gradually reducing supply to maintain *market share* (consistent with the long-term self-interested strategy suggested by Gately (2004, 2007)).[736]

It is important to note that the decrease in global petroleum prices resulting from this rulemaking could spur increased consumption of petroleum in other sectors and countries, leading to a modest uptick in GHG emissions outside of the United States. This increase in global fuel consumption could offset some portion of the GHG reduction benefits associated with these proposed rules. The agencies have not quantified this increase in global GHG emissions. We request comments, data sources and methodologies for how global rebound effects may be quantified.

(b) Macroeconomic Disruption Adjustment Costs

The second component of the oil import premium, ''avoided macroeconomic disruption/adjustment costs'', arises from the effect of oil imports on the expected cost of supply disruptions and accompanying price increases. A sudden increase in oil prices triggered by a disruption in world oil supplies has two main effects: (1) It increases the costs of oil imports in the short-run and (2) it can lead to macroeconomic contraction, dislocation and Gross Domestic Product (GDP) losses. For example, ORNL estimates the combined value of these two factors to be $6.34/barrel when U.S. oil imports are reduced in 2020, with a range from $3.07/barrel to $10.15/barrel of imported oil reduced.

Since future disruptions in foreign oil supplies are an uncertain prospect, each of the disruption cost components must be weighted by the probability that the supply of petroleum to the U.S. will actually be disrupted. Thus, the ''expected value'' of these costs—the product of the probability that a supply disruption will occur and the sum of costs from reduced economic output and the economy's abrupt adjustment to sharply higher petroleum prices—is the relevant measure of their magnitude. Further, when assessing the energy security value of a policy to reduce oil use, it is only the change in the expected costs of disruption that results from the policy that is relevant. The expected costs of disruption may change from lowering the normal (*i.e.,* pre-disruption) level of domestic petroleum use and imports, from any induced alteration in the likelihood or size of disruption, or from altering the short-run flexibility (*e.g.,* elasticity) of petroleum use.

With updated oil market and economic factors, the avoided macroeconomic disruption component of the energy security premiums is slightly lower in comparison to avoided macroeconomic disruption premiums used in previous rulemakings. Factors that contribute to moderately lowering the avoided macroeconomic disruption component are lower projected GDP, moderately lower oil prices and slightly smaller price increases during prospective shocks. For example, oil price levels are 5–19 percent lower over the 2020–2035 period, and the likely increase in oil prices in the event of an oil shock are somewhat smaller, given small increases in the responsiveness of oil supply to changes in the world price of oil. Overall, the avoided macroeconomic disruption component estimates for the oil security premiums are 2–19 percent lower over the period from 2020–2035 based upon different projected oil market and economic trends in the AEO2014 (Early Release) compared to the AEO2012 (Early Release).

There are several reasons why the avoided macroeconomic disruption premiums change only moderately. One reason is that the macroeconomic sensitivity to oil price shocks is assumed unchanged in recent years since U.S. oil consumption levels and the value share of oil in the U.S. economy remain at high levels. For example, Figure IX–2 below shows that under AEO2014 (Early Release), projected U.S. real annual oil expenditures continue to rise after 2015 to over $800 billion (2012$) by 2030. The value share of oil use in the U.S. economy remains between three and four percent, well above the levels observed from 1985 to 2005. A second factor is that oil disruption risks are little changed. The two factors influencing disruption risks are the probability of global supply interruptions and the world oil supply share from OPEC. Both factors are not significantly different from previous forecasts of oil market trends.

The energy security costs estimated here follow the oil security premium framework, which is well established in the energy economics literature. The oil import premium gained attention as a guiding concept for energy policy around the time of the second and third major post-war oil shocks (Bohi and Montgomery 1982, EMF 1982).[737] Plummer (1982)[738] provided valuable discussion of many of the key issues related to the oil import premium as well as the analogous oil stockpiling premium. Bohi and Montgomery (1982)[739] detailed the theoretical foundations of the oil import premium established many of the critical analytic relationships through their thoughtful analysis. Hogan (1981)[740] and Broadman and Hogan (1986, 1988)[741] revised and extended the established analytical framework to estimate optimal oil import premia with a more detailed accounting of macroeconomic effects.

Since the original work on energy security was undertaken in the 1980's, there have been several reviews on this topic. For example, Leiby, Jones, Curlee and Lee (1997)[742] provided an extended review of the literature and issues regarding the estimation of the premium. Parry and Darmstadter (2004)[743] also provided an overview of extant oil security premium estimates

[736] Gately, Dermot 2004. ''OPEC's Incentives for Faster Output Growth'', The Energy Journal, 25 (2):75–96; Gately, Dermot 2007. ''What Oil Export Levels Should We Expect From OPEC?'', The Energy Journal, 28(2):151–173.

[737] Bohi, Douglas R. And W. David Montgomery 1982. Social Cost of Imported and Import Policy, Annual Review of Energy, 7:37–60. Energy Modeling Forum, 1981. World Oil, EMF Report 6 (Stanford University Press: Stanford 39 CA. https//emf.stanford.edu/publications/emf-6-world-oil.

[738] Plummer, James L. (Ed.) 1982. Energy Vulnerability, ''Basic Concepts, Assumptions and Numerical Results'', pp. 13–36, (Cambridge MA: Ballinger Publishing Co.)

[739] Bohi, Douglas R. And W. David Montgomery 1982. Social Cost of Imported and U.S. Import Policy, Annual Review of Energy, 7:37–60.

[740] Hogan, William W., 1981. ''Import Management and Oil Emergencies'', Chapter 9 in Deese, 5 David and Joseph Nye, eds. Energy and Security. Cambridge, MA: Ballinger Publishing Co.

[741] Broadman, H.G. 1986. ''The Social Cost of Imported Oil,'' Energy Policy 14(3):242-252. Broadman H.G. and W.W. Hogan, 1988. ''Is an Oil Import Tariff Justified? An American Debate: The Numbers Say 'Yes'.'' The Energy Journal 9: 7–29.

[742] Leiby, Paul N., Donald W. Jones, T. Randall Curlee, and Russell Lee, Oil Imports: An Assessment of Benefits and Costs, ORNL–6851, Oak Ridge National Laboratory, November 1, 1997.

[743] Parry, Ian W.H. and Joel Darmstadter 2004. ''The Costs of U.S. Oil Dependency,'' Resources for the Future, November 17, 2004 (also published as NCEP Technical Appendix Chapter 1: Enhancing Oil Security, the National Commission on Energy Policy 2004 Ending the Energy Stalemate—A Bipartisan Strategy to Meet America's Energy Challenges.)

and estimated of some premium components.

The recent economics literature on whether oil shocks are a threat to economic stability that they once were is mixed. Some of the current literature asserts that the macroeconomic component of the energy security externality is small. For example, the National Research Council (2009) argued that the non-environmental externalities associated with dependence on foreign oil are small, and potentially trivial.[744] Analyses by Nordhaus (2007) and Blanchard and Gali (2010) question the impact of more recent oil price shocks on the economy.[745] They were motivated by attempts to explain why the economy actually expanded immediately after the last shocks, and why there was no evidence of higher energy prices being passed on through higher wage inflation. Using different methodologies, they conclude that the economy has largely gotten over its concern with dramatic swings in oil prices.

One reason, according to Nordhaus, is that monetary policy has become more accommodating to the price impacts of oil shocks. Another is that consumers have simply decided that such movements are temporary, and have noted that price impacts are not passed on as inflation in other parts of the economy. He also notes that real changes to productivity due to oil price increases are incredibly modest,[746] and that the general direction of the economy matters a great deal regarding how the economy responds to a shock. Estimates of the impact of a price shock on aggregate demand are insignificantly different from zero.

Blanchard and Gali (2010) contend that improvements in monetary policy (as noted above), more flexible labor markets, and lessening of energy intensity in the economy, combined with an absence of concurrent shocks, all contributed to lessen the impact of oil shocks after 1980. They find ''. . . the effects of oil price shocks have changed over time, with steadily smaller effects on prices and wages, as well as on output and employment.'' [747] In a comment at the chapter's end, this work is summarized as follows: ''The message of this chapter is thus optimistic in that it suggests a transformation in U.S. institutions has inoculated the economy against the responses that we saw in the past.''

At the same time, the implications of the ''Shale Oil Revolution'' are now being felt in the international markets, with current prices at four year lows. Analysts generally attribute this result in part to the significant increase in supply resulting from U.S. production, which has put liquid petroleum production on par with Saudi Arabia. The price decline is also attributed to the sustained reductions in U.S. consumption and global demand growth from fuel efficiency policies and high oil prices. The resulting decrease in foreign imports, down to about one-third of domestic consumption (from 60 percent in 2005, for example [748]), effectively permits U.S. supply to act as a buffer against artificial or other supply restrictions (the latter due to conflict or natural disaster, for example).

However, other papers suggest that oil shocks, particularly sudden supply shocks, remain a concern. Both Blanchard and Gali's and Nordhaus work were based on data and analysis through 2006, ending with a period of strong global economic growth and growing global oil demand. The Nordhaus work particularly stressed the effects of the price increase from 2002–2006 that were comparatively gradual (about half the growth rate of the 1973 event and one-third that of the 1990 event). The Nordhaus study emphasizes the robustness of the U.S. economy during a time period through 2006. This time period was just before rapid further increases in the price of oil and other commodities with oil prices more-than-doubling to over $130/barrel by mid-2008, only to drop after the onset of the largest recession since the Great Depression.

Hamilton (2012) reviewed the empirical literature on oil shocks and suggested that the results are mixed, noting that some work (*e.g.* Rasmussen and Roitman (2011) finds less evidence for economic effects of oil shocks, or declining effects of shocks (Blanchard and Gali 2010), while other work continues to find evidence regarding the economic importance of oil shocks. For example, Baumeister and Peersman (2011) found that an oil price increase of a given size seems to have a decreasing effect over time, but noted that the declining price-elasticity of demand meant that a given physical disruption had a bigger effect on price and turned out to have a similar effect on output as in the earlier data.'' [749] Hamilton observes that ''a negative effect of oil prices on real output has also been reported for a number of other countries, particularly when nonlinear functional forms have been employed'' (citing as recent examples Kim 2012, Engemann, Kliesen, and Owyang 2011 and Daniel, et. al. 2011). Alternatively, rather than a declining effect, Ramey and Vine (2010) found ''remarkable stability in the response of aggregate real variables to oil shocks once we account for the extra costs imposed on the economy in the 1970s by price controls and a complex system of entitlements that led to some rationing and shortages.'' [750]

Some of the recent literature on oil price shocks has emphasized that economic impacts depend on the nature of the oil shock, with differences between price increases caused by sudden supply loss and those caused by rapidly growing demand. Most recent analyses of oil price shocks have confirmed that ''demand-driven'' oil price shocks have greater effects on oil prices and tend to have positive effects on the economy while ''supply-driven'' oil shocks still have negative economic impacts (Baumeister, Peersman and Robays, 2010). A recent paper by Kilian and Vigfusson (2014), for example, assigned a more prominent role to the effects of price increases that are unusual, in the sense of being beyond range of recent experience. Kilian and Vigfussen also conclude that the difference in response to oil shocks may well stem from the different effects of demand- and supply-based price increases: ''One explanation is that oil price shocks are associated with a range of oil demand and oil supply shocks, some of which stimulate the U.S.

[744] National Research Council, 2009. Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use. National Academy of Science, Washington, DC.

[745] See, William Nordhaus, ''Who's Afraid of a Big Bad Oil Shock?,'' available at *http://aida.econ.yale.edu/~nordhaus/homepage/Big_Bad_Oil_Shock_Meeting.pdf*, and Olivier Blanchard and Jordi Gali, ''The macroeconomic Effects of Oil price Shocks: Why are the 2000s so different from the 1970s?,'' pp. 373–421, in *The International Dimensions of Monetary Policy,* Jordi Gali and Mark Gertler, editors, University of Chicago Press, February 2010, available at *http://www.nber.org/chapters/c0517.pdf.*

[746] In fact, ''. . . energy-price changes have no effect on multifactor productivity and very little effect on labor productivity.'' Page 19. He calculates the productivity effect of a doubling of oil prices as a decrease of 0.11 percent for one year and 0.04 percent a year for ten years. Page 5. (The doubling reflects the historical experience of the post-war shocks, as described in Table 7.1 in Blanchard and Gali, p. 380.)

[747] Blanchard and Gali, p. 414.

[748] See, Oil Price Drops on Oversupply, *http://www.oil-price.net/en/articles/oil-price-drops-on-oversupply.php*, 10/6/2014.

[749] Hamilton, J.D. (2012). Oil Prices, Exhaustible Resources, and Economic Growth. In Handbook of Energy and Climate Change. Retrieved from *http://econweb.ucsd.edu/~jhamilto/handbook_climate.pdf.*

[750] Ramey, V.A., & Vine, D.J. (2010). ''Oil, Automobiles, and the U.S. Economy: How Much have Things Really Changed?'', National Bureau of Economic Research Working Papers, WP 16067 (June). Retrieved from *http://www.nber.org/papers/w16067.pdf.*

economy in the short run and some of which slow down U.S. growth (see Kilian 2009a). How recessionary the response to an oil price shock is thus depends on the average composition of oil demand and oil supply shocks over the sample period.''

The general conclusion that oil supply-driven shocks reduce economic output is also reached in a recently published paper by Cashin et al. (2014) for 38 countries from 1979–2011. ''The results indicate that the economic consequences of a supply-driven oil-price shock are very different from those of an oil-demand shock driven by global economic activity, and vary for oil-importing countries compared to energy exporters,'' and ''oil importers [including the U.S.] typically face a long-lived fall in economic activity in response to a supply-driven surge in oil prices'' but almost all countries see an increase in real output for an oil-demand disturbance. Note that the energy security premium calculation in this analysis is based on price shocks from potential future supply events only.

Finally, despite continuing uncertainty about oil market behavior and outcomes and the sensitivity of the U.S. economy to oil shocks, it is generally agreed that it is beneficial to reduce petroleum fuel consumption from an energy security standpoint. Reducing fuel consumption reduces the amount of domestic economic activity associated with a commodity whose price depends on volatile international markets. Also, reducing U.S. oil import levels reduces the likelihood and significance of supply disruptions.

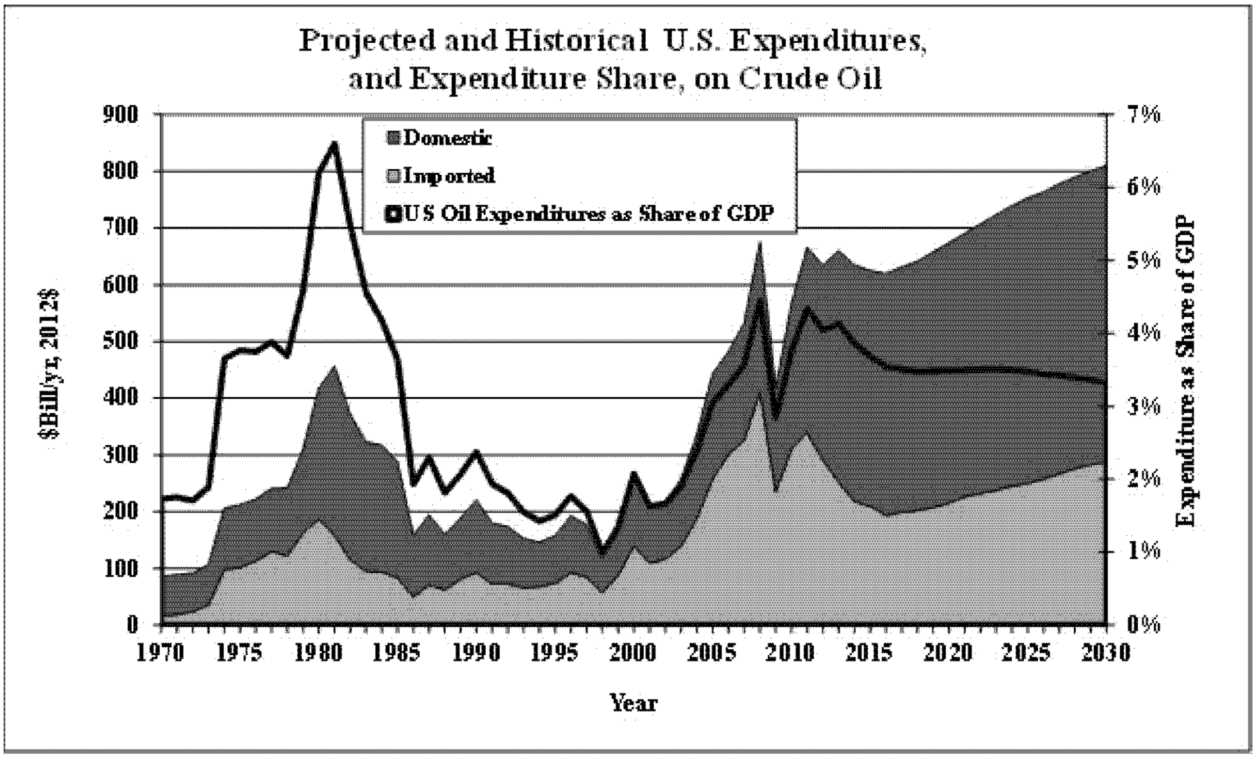

Figure IX-2 Projected and Historical U.S. Expenditures, and Expenditure Share, on Crude Oil[751]

(c) Cost of Existing U.S. Energy Security Policies

The last often-identified component of the full economic costs of U.S. oil imports are the costs to the U.S. taxpayers of existing U.S. energy security policies. The two primary examples are maintaining the Strategic Petroleum Reserve (SPR) and maintaining a military presence to help secure a stable oil supply from potentially vulnerable regions of the world. The SPR is the largest stockpile of government-owned emergency crude oil in the world. Established in the aftermath of the 1973/1974 oil embargo, the SPR provides the U.S. with a response option should a disruption in commercial oil supplies threaten the U.S. economy. It also allows the U.S. to meet part of its International Energy Agency obligation to maintain emergency oil stocks, and it provides a national defense fuel reserve. While the costs for building and maintaining the SPR are more clearly related to U.S. oil use and imports, historically these costs have not varied in response to changes in U.S. oil import levels. Thus, while the effect of the SPR in moderating price shocks is factored into the ORNL analysis, the cost of maintaining the SPR is excluded.

U.S. military costs are excluded from the analysis performed by ORNL because their attribution to particular missions or activities is difficult, and because it is not clear that these outlays would decline in response to incremental reductions in U.S. oil imports. Most military forces serve a broad range of security and foreign policy objectives. The agencies also recognize that attempts to attribute some share of U.S. military costs to oil imports are further challenged by the need to estimate how those costs might

[751] Historical data are from EIA Annual Energy Review, various editions. For data since 2011 and projected data: Source is EIA Annual Energy Outlook (AEO) 2014 (Reference Case). See Table 11, file ''aeotab_11.xlsx'' and Table 20 (Macroeconomic Indicators,'' (file ''aeotab_20.xlsx'').

vary with incremental variations in U.S. oil imports.

(3) Energy Security Benefits of This Program

Using the ORNL ''oil premium'' methodology, updating world oil price values and energy trends using AEO 2014 (Early Release) and using the estimated fuel savings from the proposed rules estimated from the MOVES/CAFE models, the agencies has calculated the annual energy security benefits of this proposed rule through 2050.[752] Since the agencies are taking a global perspective with respect to valuing greenhouse gas benefits from the rules, only the avoided macroeconomic adjustment/disruption portion of the energy security premium is used in the energy security benefits estimates present below. These results are shown below in Table IX–25. The agencies have also calculated the net present value at 3 percent and 7 percent discount rates of model year lifetime benefits associated with energy security; these values are presented in Table IX–26.

TABLE IX–25—ANNUAL U.S. ENERGY SECURITY BENEFITS OF THE PREFERRED ALTERNATIVE AND NET PRESENT VALUES AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[In millions of 2012$] [a]

Year	Benefits (2012$)
2018	10
2019	20
2020	31
2021	77
2022	140
2023	211
2024	328
2025	456
2026	596
2027	770
2028	947
2029	1,126
2030	1,306
2035	2,156
2040	2,920
2050	3,498
NPV, 3%	28,947
NPV, 7%	11,857

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE IX–26—DISCOUNTED MODEL YEAR LIFETIME ENERGY SECURITY BENEFITS DUE TO THE PREFERRED ALTERNATIVE AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of 2012$] [a]

Calendar year	3% discount rate	7% discount rate
2018	86	60
2019	85	56
2020	84	53
2021	534	326
2022	579	341
2023	621	353
2024	996	546
2025	1,060	560
2026	1,121	571
2027	1,375	676
2028	1,388	657
2029	1,397	637
Sum	9,325	4,837

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

J. Other Impacts

(1) Costs of Noise, Congestion and Accidents Associated With Additional (Rebound) Driving

Although it provides benefits to drivers as described above, increased vehicle use associated with the rebound effect also contributes to increased traffic congestion, motor vehicle accidents, and highway noise. Depending on how the additional travel is distributed over the day and where it takes place, additional vehicle use can contribute to traffic congestion and delays by increasing the number of vehicles using facilities that are already heavily traveled. These added delays impose higher costs on drivers and other vehicle occupants in the form of increased travel time and operating expenses. At the same time, this additional travel also increases costs associated with traffic accidents and vehicle noise.

The agencies estimate these costs using the same methodology as used in the two light-duty and the HD Phase 1 rule analyses, which relies on estimates of congestion, accident, and noise costs imposed by automobiles and light trucks developed by the Federal Highway Administration to estimate these increased external costs caused by added driving.[753] We provide the details behind the estimates in Chapter 8.7 of the draft RIA. The agencies request comment on all input metrics used in the analysis of accidents, congestion and noise and on the calculation methodology. Table IX–27 presents the estimated annual impacts associated with accidents, congestion and noise along with net present values at both 3 percent and 7 percent discount rates. Table IX–28 presents the estimated discounted model year lifetime impacts associated with accidents, congestion and noise.

TABLE IX–27—ANNUAL COSTS ASSOCIATED WITH ACCIDENTS, CONGESTION AND NOISE AND NET PRESENT VALUES AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of 2012$] [a]

Calendar year	Costs of accidents, congestion, and noise
2018	$0
2019	0
2020	0
2021	117
2022	172
2023	226
2024	279
2025	330
2026	379
2027	425
2028	467
2029	506
2030	542
2035	676
2040	758
2050	871
NPV, 3%	9,334
NPV, 7%	4,202

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[752] In order to determine the energy security benefits beyond 2040, we use the 2040 energy security premium multiplied by the estimate fuel savings from the proposed rule. Since the AEO 2014 (Early Release) only goes to 2040, we only calculate energy security premiums to 2040.

[753] These estimates were developed by FHWA for use in its 1997 Federal Highway Cost Allocation Study; *http://www.fhwa.dot.gov/policy/hcas/final/index.htm* (last accessed July 8, 2012).

TABLE IX–28—DISCOUNTED MODEL YEAR LIFETIME COSTS OF ACCIDENTS, CONGESTION AND NOISE AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of 2012$] [a]

Calendar year	3% discount rate	7% discount rate
2018	132	85
2019	146	94
2020	162	103
2021	450	284
2022	438	266
2023	427	250
2024	424	239
2025	422	229
2026	420	219
2027	415	209
2028	409	198
2029	402	187
Sum	4,247	2,362

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(2) Benefits Associated With Reduced Refueling Time

By reducing the frequency with which drivers typically refuel their vehicles and by extending the upper limit of the range that can be traveled before requiring refueling (*i.e.,* future fuel tank sizes remain constant), savings would be realized associated with less time spent refueling vehicles. Alternatively, refill intervals may remain the same (*i.e.,* future fuel tank sizes get smaller), resulting in the same number of refills as today but less time spent per refill because there would be less fuel to refill. The agencies have estimated this impact using the former approach—by assuming that future tank sizes remain constant.

The savings in refueling time are calculated as the total amount of time the driver of a typical truck in each class would save each year as a consequence of pumping less fuel into the vehicle's tank. The calculation does not include any reduction in time spent searching for a fueling station or other time spent at the station; it is assumed that time savings occur only when truck operators are actually refueling their vehicles.

The calculation uses the reduced number of gallons consumed by truck type and divides that value by the tank volume and refill amount to get the number of refills, then multiplies that by the time per refill to determine the number of hours saved in a given year. The calculation then applies DOT-recommended values of travel time savings to convert the resulting time savings to their economic value, including a 1.2 percent growth rate in those time savings going forward.[754] The input metrics used in the analysis are presented in greater detail in draft RIA Chapter 9.7. The annual benefits associated with reduced refueling time are shown in Table IX–29 along with net present values at both 3 percent and 7 percent discount rates. The discounted model year lifetime benefits are shown in Table IX–30.

TABLE IX–29—ANNUAL REFUELING BENEFITS AND NET PRESENT VALUES AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of 2012$] [a]

Calendar year	Refueling benefits
2018	3
2019	6
2020	9
2021	25
2022	47
2023	72
2024	113
2025	157
2026	205
2027	266
2028	327
2029	386
2030	444
2035	698
2040	890
2050	1,195
NPV, 3%	9,410
NPV, 7%	3,868

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE IX–30—DISCOUNTED MODEL YEAR LIFETIME REFUELING BENEFITS USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of 2012$] [a]

Model year	3% discount rate	7% discount rate
2018	23	16
2019	22	15
2020	21	14
2021	163	101
2022	184	110
2023	203	117
2024	325	181
2025	349	187
2026	372	191
2027	466	231
2028	465	222
2029	463	213
Sum	3,055	1,597

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[754] U.S. Department of Transportation, Valuation of Travel Guidance, July 9, 2014, at page 14.

(3) Benefits of Increased Travel Associated With Rebound Driving

The increase in travel associated with the rebound effect produces additional benefits to vehicle owners and operators, which reflect the value of the added (or more desirable) social and economic opportunities that become accessible with additional travel. The analysis estimates the economic benefits from increased rebound-effect driving as the sum of fuel expenditures incurred plus the consumer surplus from the additional accessibility it provides. As evidenced by the fact that vehicles make more frequent or longer trips when the cost of driving declines, the benefits from this added travel exceed added expenditures for the fuel consumed. The amount by which the benefits from this increased driving exceed its increased fuel costs measures the net benefits from the additional travel, usually referred to as increased consumer surplus.

The agencies' analysis estimates the economic value of the increased consumer surplus provided by added driving using the conventional approximation, which is one half of the product of the decline in vehicle operating costs per vehicle-mile and the resulting increase in the annual number of miles driven. Because it depends on the extent of improvement in fuel economy, the value of benefits from increased vehicle use changes by model year and varies among alternative standards. Under even those alternatives that would impose the highest standards, however, the magnitude of the consumer surplus from additional vehicle use represents a small fraction of this benefit.

The annual benefits associated with increased travel are shown in Table IX–31 along with net present values at both

3 percent and 7 percent discount rates. The discounted model year lifetime benefits are shown in Table IX–32.

TABLE IX–31—ANNUAL VALUE OF INCREASED TRAVEL AND NET PRESENT VALUES AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of 2012$] [a]

Calendar year	Benefits of increased travel
2018	0
2019	0
2020	0
2021	445
2022	636
2023	821
2024	1,001
2025	1,179
2026	1,346
2027	1,506
2028	1,647
2029	1,783
2030	1,909
2035	2,445
2040	2,873
2050	3,286
NPV, 3%	34,240
NPV, 7%	15,316

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE IX–32—DISCOUNTED MODEL YEAR LIFETIME VALUE OF INCREASED TRAVEL AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Millions of 2012$] [a]

Calendar year	3% discount rate	7% discount rate
2018	$554	$353
2019	618	390
2020	686	429
2021	1,510	942
2022	1,488	894
2023	1,463	847
2024	1,434	799
2025	1,442	774
2026	1,447	748
2027	1,421	708
2028	1,415	678
2029	1,406	649
Sum	14,884	8,211

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

K. Summary of Benefits and Costs

This section presents the costs, benefits, and other economic impacts of the proposed Phase 2 standards. It is important to note that NHTSA's proposed fuel consumption standards and EPA's proposed GHG standards would both be in effect, and would jointly lead to increased fuel efficiency and reductions in GHG and non-GHG emissions. The individual categories of benefits and costs presented in the tables below are defined more fully and presented in more detail in Chapter 8 of the draft RIA. These include:

• The vehicle program costs (costs of complying with the vehicle CO_2 and fuel consumption standards),

• changes in fuel expenditures associated with reduced fuel use by more efficient vehicles and increased fuel use associated with the ''rebound'' effect, both of which result from the program,

• the global economic value of reductions in GHGs,

• the economic value of reductions in non-GHG pollutants,

• costs associated with increases in noise, congestion, and accidents resulting from increased vehicle use,

• savings in drivers' time from less frequent refueling,

• benefits of increased vehicle use associated with the ''rebound'' effect, and

• the economic value of improvements in U.S. energy security impacts.

For a discussion of the cost of ownership and the agencies' payback analysis of vehicles covered by this proposal, please see Section IX.M.

The agencies conducted coordinated and complementary analyses using two analytical methods referred to as Method A and Method B. For an explanation of these methods, please see Section I.D. And as discussed in Section X.A.1, the agencies present estimates of benefits and costs that are measured against two different assumptions about improvements in fuel efficiency that might occur in the absence of the Phase 2 standards. The first case (Alternative 1a) uses a baseline that projects very little improvement in new vehicles in the absence of new Phase 2 standards, and the second (Alternative 1b) uses a more dynamic baseline that projects more significant improvements in vehicle fuel efficiency.

Table IX–33 shows benefits and costs for the proposed standards from the perspective of a program designed to improve the nation's energy security and conserve energy by improving fuel efficiency. From this viewpoint, technology costs occur when the vehicle is purchased. Fuel savings are counted as benefits that occur over the lifetimes of the vehicles produced during the model years subject to the Phase 2 standards as they consume less fuel. The table shows that benefits far outweigh the costs, and the preferred alternative is anticipated to result in large net benefits to the U.S economy.

TABLE IX–33—LIFETIME BENEFITS & COSTS OF THE PREFERRED ALTERNATIVE FOR MODEL YEARS 2018–2029 VEHICLES USING ANALYSIS METHOD A

[Billions of 2012$ discounted at 3% and 7%]

Category	Baseline 1a		Baseline 1b	
	3%	7%	3%	7%
Vehicle Program: Technology and Indirect Costs, Normal Profit on Additional Investments	25.4	17.1	25.0	16.8
Additional Routine Maintenance	1.1	0.6	1.0	0.6
Congestion, Accidents, and Noise from Increased Vehicle Use	4.7	2.8	4.5	2.6
Total Costs	31.1	20.5	30.5	20.0
Fuel Savings (valued at pre-tax prices)	175.1	94.2	165.1	89.2
Savings from Less Frequent Refueling	3.1	1.6	2.9	1.5
Economic Benefits from Additional Vehicle Use	15.1	8.4	14.7	8.2
Reduced Climate Damages from GHG Emissions[a]	34.9	34.9	32.9	32.9
Reduced Health Damages from Non-GHG Emissions	38.8	20.7	37.2	20.0
Increased U.S. Energy Security	8.9	4.7	8.1	4.3
Total Benefits	276	165	261	156
Net Benefits	245	144	231	136

Note:

[a] Benefits and net benefits use the 3 percent average global SCC value applied only to CO_2 emissions; GHG reductions include CO_2, CH_4, N_2O and HFC reductions, and include benefits to other nations as well as the U.S. See Draft RIA Chapter 8.5 and Preamble Section IX.G for further discussion.

Table IX–34, Table IX–35, and Table IX–36 report benefits and cost from the perspective of reducing GHG. Table IX–34 shows the annual impacts and net benefits of the preferred alternative for selected future years, together with the net present values of cumulative annual impacts from 2018 through 2050, discounted at 3 percent and 7 percent rates. Table IX–35 and Table IX–36 show the discounted lifetime costs and benefits for each model year affected by the Phase 2 standards at 3 percent and 7 percent discount rates, respectively.

TABLE IX–34—ANNUAL BENEFITS & COSTS OF THE PREFERRED ALTERNATIVE AND NET PRESENT VALUES AT 3% AND 7% DISCOUNT RATES USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Billions of 2012$][a]

	2018	2021	2024	2030	2035	2040	2050	NPV, 3%	NPV, 7%
Vehicle program	−0.1	−2.4	−3.7	−5.4	−5.9	−6.3	−7.0	−86.8	−41.1
Maintenance	0.0	0.0	−0.1	−0.1	−0.1	−0.1	−0.1	−1.8	−0.9
Pre-tax fuel	0.2	1.7	6.9	24.0	37.2	47.8	57.5	495.6	206.7
Energy security	0.0	0.1	0.3	1.3	2.2	2.9	3.5	28.9	11.9
Accidents/Congestion/Noise	0.0	−0.1	−0.3	−0.5	−0.7	−0.8	−0.9	−9.3	−4.2
Refueling impacts	0.0	0.0	0.1	0.4	0.7	0.9	1.2	9.4	3.9
Travel value	0.0	0.4	1.0	1.9	2.4	2.9	3.3	34.2	15.3
Non-GHG impacts	0.0 to 0.1	0.4 to 0.9	1.0 to 2.4	3.3 to 8.3	4.8 to 12.1	5.7 to 14.3	7.0 to 17.5	69. to 157.0	26.6 to 60.4
SCC[b][c]									
SCC_CO_2; 5% Avg	0.0	0.1	0.4	1.5	2.5	3.3	5.0	22.1	22.1
SCC_CO_2; 3% Avg	0.0	0.3	1.3	4.8	7.4	9.7	13.6	103.1	103.1
SCC_CO_2; 2.5% Avg	0.1	0.5	1.9	6.9	10.6	13.7	18.5	164.1	164.1
SCC_CO_2; 3% 95th	0.1	1.0	4.0	14.6	23.2	30.3	42.0	320.5	320.5
Net benefits [d]									
SCC_CO_2; 5% Avg	0.2	0.4	6.4	28.8	46.8	60.6	74.6	605.8	257.1
SCC_CO_2; 3% Avg	0.2	0.7	7.3	32.1	51.7	66.9	83.2	686.8	338.1
SCC_CO_2; 2.5% Avg	0.2	0.8	7.9	34.2	54.9	70.9	88.2	747.8	399.1
SCC_CO_2; 3% 95th	0.3	1.3	10.0	41.9	67.5	87.6	111.7	904.1	555.5

Notes:

[a] Positive values denote decreased social costs (benefits); negative values denote increased social costs. For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Net present value of reduced CO_2 emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SC–CO_2 at 5, 3, 2.5 percent) is used to calculate net present value of SC–CO_2 for internal consistency. Refer to the SCC TSD for more detail.

[c] Section IX.G notes that SCCO_2 increases over time. For the years 2012–2050, the SC–CO_2 estimates range as follows: for Average SC–CO_2 at 5%: $12–$28; for Average SC–CO_2 at 3%: $37–$77; for Average SC–CO_2 at 2.5%: $58–$105; and for 95th percentile SC–CO_2 at 3%: $105–$237. Section IX.G also presents these SC–CO_2 estimates.

[d] Net impacts are the summation of results within columns of the table with the exception that the net impacts at each SC–CO_2 value include only the SC–CO_2 impacts at that value.

TABLE IX–35—DISCOUNTED MODEL YEAR LIFETIME BENEFITS & COSTS OF THE PREFERRED ALTERNATIVE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Billions of 2012$ discounted at 3%] [a]

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Sum
Vehicle program	−0.1	−0.1	−0.1	−2.0	−1.9	−1.9	−2.8	−2.7	−2.7	−3.7	−3.6	−3.5	−25.1
Maintenance	−0.1	0.0	0.0	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−1.1
Pre-tax fuel	1.9	1.9	1.8	11.1	11.5	11.9	18.9	19.6	20.2	24.1	24.1	24.1	171.1
Energy security	0.1	0.1	0.1	0.5	0.6	0.6	1.0	1.1	1.1	1.4	1.4	1.4	9.3
Accidents/Congestion/Noise	−0.1	−0.1	−0.2	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−4.2
Refueling	0.0	0.0	0.0	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.5	3.1
Travel value	0.6	0.6	0.7	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	14.9
Non-GHG	0.2 to 0.5	0.2 to 0.4	0.2 to 0.4	2.0 to 4.5	2.0 to 4.5	2.0 to 4.5	2.9 to 6.6	3.0 to 6.8	2.6 to 5.9	3.1 to 6.9	3.1 to 6.9	3.1 to 7.0	24.4 to 55.0
SCC; [b c].													
SCC_CO_2; 5% Avg	0.1	0.1	0.1	0.5	0.5	0.5	0.9	0.9	0.9	1.1	1.1	1.1	7.8
SCC_CO_2; 3% Avg	0.4	0.4	0.4	2.2	2.3	2.3	3.7	3.9	4.0	4.8	4.8	4.9	34.0
SCC_CO_2; 2.5% Avg	0.6	0.6	0.6	3.4	3.5	3.6	5.8	6.1	6.3	7.6	7.6	7.7	53.4
SCC_CO_2; 3% 95th	1.1	1.1	1.1	6.6	6.9	7.2	11.5	12.0	12.4	14.9	15.0	15.1	105.0
Net benefits [d]													
SCC_CO_2; 5% Avg	2.8	2.7	2.7	14.6	15.1	15.5	23.9	25.0	25.1	29.2	29.4	29.4	215.5
SCC_CO_2; 3% Avg	3.0	3.0	3.0	16.2	16.8	17.3	26.8	28.0	28.2	33.0	33.1	33.2	241.7
SCC_CO_2; 2.5% Avg	3.2	3.2	3.2	17.4	18.1	18.6	28.9	30.2	30.5	35.7	35.9	36.0	261.1
SCC_CO_2; 3% 95th	3.8	3.8	3.7	20.7	21.5	22.1	34.5	36.0	36.6	43.1	43.3	43.5	312.7

Notes:

[a] Positive values denote decreased social costs (benefits); negative values denote increased social costs. For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.c

[b] Net present value of reduced CO_2 emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SC–CO_2 at 5, 3, 2.5 percent) is used to calculate net present value of SC–CO_2 for internal consistency. Refer to the SCC TSD for more detail.

[c] Section IX.G notes that SCC increases over time. For the years 2012–2050, the SCC estimates range as follows: for Average SC–CO_2 at 5%: $12–$28; for Average SC–CO_2 at 3%: $37–$77; for Average SC–CO_2 at 2.5%: $58–$105; and for 95th percentile SC–CO_2 at 3%: $105–$237. Section IX.G also presents these SCC estimates.

[d] Net impacts are the summation of results within columns of the table with the exception that the net impacts at each SC–CO_2 value include only the SCCO$_2$ impacts at that value.

TABLE IX–36—DISCOUNTED MODEL YEAR LIFETIME BENEFITS & COSTS OF THE PREFERRED ALTERNATIVE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[Billions of 2012$ discounted at 7%] [a thnsp;b]

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Sum
Vehicle program	−0.1	−0.1	−0.1	−1.6	−1.4	−1.4	−1.9	−1.8	−1.7	−2.3	−2.1	−2.0	−16.6
Maintenance	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	0.0	−0.6
Pre-tax fuel	1.4	1.3	1.2	6.9	6.9	6.8	10.5	10.4	10.4	11.9	11.5	11.0	90.1
Energy security	0.1	0.1	0.1	0.3	0.3	0.4	0.5	0.6	0.6	0.7	0.7	0.6	4.8
Accidents/Congestion/Noise	−0.1	−0.1	−0.1	−0.3	−0.3	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2	−2.4
Refueling	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	1.6
Travel value	0.4	0.4	0.4	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.6	8.2
Non-GHG	0.1 to 0.3	0.1 to 0.3	0.1 to 0.3	1.1 to 2.5	1.1 to 2.4	1.0 to 2.3	1.4 to 3.3	1.4 to 3.2	1.2 to 2.7	1.3 to 3.0	1.3 to 2.9	1.3 to 2.8	11.5 to 26.0
SCC [b c]													
SCC_CO_2; 5% Avg	0.1	0.1	0.1	0.5	0.5	0.5	0.9	0.9	0.9	1.1	1.1	1.1	7.8
SCC_CO_2; 3% Avg	0.4	0.4	0.4	2.2	2.3	2.3	3.7	3.9	4.0	4.8	4.8	4.9	34.0
SCC_CO_2; 2.5% Avg	0.6	0.6	0.6	3.4	3.5	3.6	5.8	6.1	6.3	7.6	7.6	7.7	53.4
SCC_CO_2; 3% 95th	1.1	1.1	1.1	6.6	6.9	7.2	11.5	12.0	12.4	14.9	15.0	15.1	105.0
Net benefits [d]													
SCC_CO_2; 5% Avg	1.9	1.8	1.7	8.7	8.7	8.7	13.0	13.1	12.7	14.3	13.8	13.4	111.8
SCC_CO_2; 3% Avg	2.2	2.1	2.0	10.3	10.4	10.5	15.8	16.1	15.8	18.0	17.6	17.2	138.0
SCC_CO_2; 2.5% Avg	2.4	2.3	2.2	11.5	11.7	11.8	17.9	18.3	18.1	20.7	20.4	20.0	157.4
SCC_CO_2; 3% 95th	2.9	2.8	2.8	14.8	15.1	15.3	23.6	24.2	24.2	28.1	27.8	27.4	209.0

Notes:

[a] Positive values denote decreased social costs (benefits); negative values denote increased social costs. For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Net present value of reduced CO_2 emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SC–CO_2 at 5, 3, 2.5 percent) is used to calculate net present value of SCC for internal consistency. Refer to the SCC TSD for more detail.

[c] Section IX.G notes that SC–CO_2 increases over time. For the years 2012–2050, the SC–CO_2 estimates range as follows: for Average SC–CO_2 at 5%: $12–$28; for Average SC–CO_2 at 3%: $37–$77; for Average SC–CO_2 at 2.5%: $58–$105; and for 95th percentile SCCO$_2$ at 3%: $105–$237. Section IX.G also presents these SC–CO_2 estimates.

[d] Net impacts are the summation of results within columns of the table with the exception that the net impacts at each SC–CO_2 value include only the SC–CO_2 impacts at that value.

The agencies note that this proposal accounts for other regulations that have been finalized. Until regulations are finalized, there is no assurance they will be implemented and thus any potential provisions of those potential regulations are uncertain. The agencies note that NHTSA has started the rulemaking process for regulations that involve technologies that could potentially affect medium- and heavy-duty fuel consumption (*e.g.* vehicle speed limiters, etc.). If any such rulemakings are finalized prior to this rulemaking becoming final, this rulemaking will take those regulations into account.

L. Employment Impacts

Executive Order 13563 (January 18, 2011) directs federal agencies to consider regulatory impacts on, among other criteria, job creation.[755] According to the Executive Order ''Our regulatory system must protect public health, welfare, safety, and our environment while promoting economic growth, innovation, competitiveness, and job creation. It must be based on the best available science.'' Analysis of employment impacts of a regulation is not part of a standard benefit-cost analysis (except to the extent that labor costs contribute to costs). Employment impacts of federal rules are of general interest, however, and have been particularly so, historically, in the auto sector during periods of challenging labor market conditions. For this reason, we are describing the connections of these proposed standards to employment in the regulated sector, the motor vehicle manufacturing sector, as well as the motor vehicle body and trailer and motor vehicle parts manufacturing sectors.

The overall effect of the proposed rules on motor vehicle sector employment depends on the relative magnitude of output and substitution effects, described below. Because we do not have quantitative estimates of the output effect, and only a partial estimate of the substitution effect, we cannot reach a quantitative estimate of the overall employment effects of the proposed rules on motor vehicle sector employment or even whether the total effect will be positive or negative.

According to the U.S. Bureau of Labor Statistics, in 2014, about 850,000 people in the U.S. were employed in the Motor Vehicle and Parts Manufacturing Sector (NAICS 3361, 3362, and 3363),[756] the directly regulated sector. The employment effects of these proposed rules are expected to expand beyond the regulated sector. Though some of the parts used to achieve the proposed standards are likely to be built by motor vehicle manufacturers (including trailer manufacturers) themselves, the motor vehicle parts manufacturing sector also plays a significant role in providing those parts, and will also be affected by changes in vehicle sales. Changes in truck sales, discussed in Section IX.F.(2), could also affect employment for truck and trailer vendors. As discussed in Section IX.C., this proposed rule is expected to reduce the amount of fuel these vehicles use, and thus affect the petroleum refinery and supply industries as well. Finally, since the net reduction in cost associated with these proposed rules is expected to lead to lower transportation and shipping costs, in a competitive market a substantial portion of those cost savings will be passed along to consumers, who then will have additional discretionary income (how much of the cost is passed along to consumers depends on market structure and the relative price elasticities). The proposed rules are not expected to have any notable inflationary or recessionary effect.

The employment effects of environmental regulation are difficult to disentangle from other economic changes and business decisions that affect employment, over time and across regions and industries. In light of these difficulties, we lean on economic theory to provide a constructive framework for approaching these assessments and for better understanding the inherent complexities in such assessments. Neoclassical microeconomic theory describes how profit-maximizing firms adjust their use of productive inputs in response to changes in their economic conditions.[757] Berman and Bui (2001, pp. 274–75) model two components that drive changes in firm-level labor demand: Output effects and substitution effects.[758] Regulation can affect the profit-maximizing quantity of output by changing the marginal cost of production. If regulation causes marginal cost to increase, it will place upward pressure on output prices, leading to a decrease in the quantity demanded, and resulting in a decrease in production. The output effect describes how, holding labor intensity constant, a decrease in production causes a decrease in labor demand. As noted by Berman and Bui, although many assume that regulation increases marginal cost, it need not be the case. A regulation could induce a firm to upgrade to less polluting and more efficient equipment that lowers marginal production costs, or it may induce use of technologies that may prove popular with buyers or provide positive network externalities (see Section IX. A. for discussion of this effect). In such a case, output could increase.

The substitution effect describes how, holding output constant, regulation affects labor intensity of production. Although increased environmental regulation may increase use of pollution control equipment and energy to operate that equipment, the impact on labor demand is ambiguous. For example, equipment inspection requirements, specialized waste handling, or pollution technologies that alter the production process may affect the number of workers necessary to produce a unit of output. Berman and Bui (2001) model the substitution effect as the effect of regulation on pollution control equipment and expenditures required by the regulation and the corresponding change in labor intensity of production.

In summary, as output and substitution effects may be positive or negative, theory alone cannot predict the direction of the net effect of regulation on labor demand at the level of the regulated firm. Operating within the bounds of standard economic theory, empirical estimation of net employment effects on regulated firms is possible when data and methods of sufficient detail and quality are available. The literature, however, illustrates difficulties with empirical estimation. For example, studies sometimes rely on confidential plant-level employment data from the U.S. Census Bureau, possibly combined with pollution abatement expenditure data that are too dated to be reliably informative. In addition, the most commonly used empirical methods do not permit estimation of net effects.

The conceptual framework described thus far focused on regulatory effects on plant-level decisions within a regulated industry. Employment impacts at an individual plant do not necessarily represent impacts for the sector as a whole. The approach must be modified when applied at the industry level.

At the industry level, labor demand is more responsive if: (1) The price elasticity of demand for the product is high, (2) other factors of production can

[755] Available at *http://www.whitehouse.gov/sites/default/files/omb/inforeg/eo12866/eo13563_01182011.pdf.*

[756] U.S. Department of Labor, Bureau of Labor Statistics. ''Automotive Industry; Employment, Earnings, and Hours.'' *http://www.bls.gov/iag/tgs/iagauto.htm*, accessed 8/18/14.

[757] See Layard, P.R.G., and A.A. Walters (1978), Microeconomic Theory (McGraw-Hill, Inc.), Chapter 9 (Docket ID EPA–HQ–OAR–2014–0827), a standard microeconomic theory textbook treatment, for a discussion.

[758] Berman, E. and L.T.M. Bui (2001). ''Environmental Regulation and Labor Demand: Evidence from the South Coast Air Basin.'' Journal of Public Economics 79(2): 265–295 (Docket EPA–HQ–OAR–2014–0827). The authors also discuss a third component, the impact of regulation on factor prices, but conclude that this effect is unlikely to be important for large competitive factor markets, such as labor and capital. Morgenstern, Pizer and Shih (Morgenstern, Richard D., William A. Pizer, and Jhih-Shyang Shih (2002). ''Jobs versus the Environment: An Industry-Level Perspective.'' Journal of Environmental Economics and Management 43: 412–436) use a similar model, but they break the employment effect into three parts: (1) A demand effect; (2) a cost effect; and (3) a factor-shift effect.

be easily substituted for labor, (3) the supply of other factors is highly elastic, or (4) labor costs are a large share of total production costs.[759] For example, if all firms in an industry are faced with the same regulatory compliance costs and product demand is inelastic, then industry output may not change much, and output of individual firms may change slightly.[760] In this case, the output effect may be small, while the substitution effect depends on input substitutability. Suppose, for example, that new equipment for fuel efficiency improvements requires labor to install and operate. In this case, the substitution effect may be positive, and with a small output effect, the total effect may be positive. As with potential effects for an individual firm, theory cannot determine the sign or magnitude of industry-level regulatory effects on labor demand. Determining these signs and magnitudes requires additional sector-specific empirical study. For environmental rules, much of the data needed for these empirical studies is not publicly available, would require significant time and resources in order to access confidential U.S. Census data for research, and also would not be necessary for other components of a typical RIA.

In addition to changes to labor demand in the regulated industry, net employment impacts encompass changes in other related sectors. For example, the proposed standards are expected to increase demand for fuel-saving technologies. This increased demand may increase revenue and employment in the firms providing these technologies. At the same time, the regulated industry is purchasing the equipment, and these costs may impact labor demand at regulated firms. Therefore, it is important to consider the net effect of compliance actions on employment across multiple sectors or industries.

If the U.S. economy is at full employment, even a large-scale environmental regulation is unlikely to have a noticeable impact on aggregate net employment.[761] Instead, labor would primarily be reallocated from one productive use to another, and net national employment effects from environmental regulation would be small and transitory (*e.g.,* as workers move from one job to another).[762]

Affected sectors may experience transitory effects as workers change jobs. Some workers may retrain or relocate in anticipation of new requirements or require time to search for new jobs, while shortages in some sectors or regions could bid up wages to attract workers. These adjustment costs can lead to local labor disruptions. Although the net change in the national workforce is expected to be small, localized reductions in employment may adversely impact individuals and communities just as localized increases may have positive impacts.

If the economy is operating at less than full employment, economic theory does not clearly indicate the direction or magnitude of the net impact of environmental regulation on employment; it could cause either a short-run net increase or short-run net decrease.[763] An important research question is how to accommodate unemployment as a structural feature in economic models. This feature may be important in assessing large-scale regulatory impacts on employment.[764]

Environmental regulation may also affect labor supply. In particular, pollution and other environmental risks may impact labor productivity or employees' ability to work.[765] While the theoretical framework for analyzing labor supply effects is analogous to that for labor demand, it is more difficult to study empirically. There is a small emerging literature described in the next section that uses detailed labor and environmental data to assess these impacts.

To summarize, economic theory provides a framework for analyzing the impacts of environmental regulation on employment. The net employment effect incorporates expected employment changes (both positive and negative) in the regulated sector and elsewhere. Labor demand impacts for regulated firms, and also for the regulated industry, can be decomposed into output and substitution effects which may be either negative or positive. Estimation of net employment effects for regulated sectors is possible when data of sufficient detail and quality are available. Finally, economic theory suggests that labor supply effects are also possible. In the next section, we discuss the empirical literature.

(1) Current State of Knowledge Based on the Peer-Reviewed Literature

In the labor economics literature there is an extensive body of peer-reviewed empirical work analyzing various aspects of labor demand, relying on the above theoretical framework.[766] This work focuses primarily on the effects of employment policies, *e.g.* labor taxes, minimum wage, etc.[767] In contrast, the peer-reviewed empirical literature specifically estimating employment effects of environmental regulations is very limited. Several empirical studies [768] suggest that net employment impacts may be zero or slightly positive but small even in the regulated sector. Other research suggests that more highly regulated counties may generate fewer jobs than less regulated ones.[769] However, since these latter studies compare more regulated to less regulated counties, they overstate the net national impact of regulation to the extent that regulation causes plants to locate in one area of the country rather than another. List *et al.* (2003) [770] find

[759] See Ehrenberg, Ronald G., and Robert S. Smith (2000), Modern Labor Economics: Theory and Public Policy (Addison Wesley Longman, Inc.), p. 108.

[760] This discussion draws from Berman, E. and L.T.M. Bui (2001). ''Environmental Regulation and Labor Demand: Evidence from the South Coast Air Basin.'' Journal of Public Economics 79(2): 265–295 (Docket EPA–HQ–OAR–2014–0827), p. 293.

[761] Full employment is a conceptual target for the economy where everyone who wants to work and is available to do so at prevailing wages is actively employed. The unemployment rate at full employment is not zero.

[762] Arrow *et al.* (1996). ''Benefit-Cost Analysis in Environmental, Health, and Safety Regulation: A Statement of Principles.'' American Enterprise Institute, the Annapolis Center, and Resources for the Future. See discussion on bottom of p. 6. In practice, distributional impacts on individual workers can be important, as discussed later in this section.

[763] Schmalensee, Richard, and Robert N. Stavins. ''A Guide to Economic and Policy Analysis of EPA's Transport Rule.'' White paper commissioned by Excelon Corporation, March 2011.

[764] Klaiber, H. Allen, and V. Kerry Smith (2012). ''Developing General Equilibrium Benefit Analyses for Social Programs: An Introduction and Example.'' *Journal of Benefit-Cost Analysis* 3(2).

[765] *E.g.* Graff Zivin, J., and M. Neidell (2012). ''The Impact of Pollution on Worker Productivity.'' *American Economic Review* 102: 3652–3673.

[766] See Hamermesh (1993), Labor Demand (Princeton, NJ: Princeton University Press), Chapter 2 (Docket EPA–HQ–OAR–2014–0827) for a detailed treatment.

[767] See Ehrenberg, Ronald G., and Robert S. Smith (2000), Modern Labor Economics: Theory and Public Policy (Addison Wesley Longman, Inc.), Chapter 4 (Docket EPA–HQ–OAR–2014–0827), for a concise overview.

[768] Berman, E. and L.T.M. Bui (2001). ''Environmental Regulation and Labor Demand: Evidence from the South Coast Air Basin.'' Journal of Public Economics 79(2): 265–295 (Docket EPA–HQ–OAR–2014–0827). Morgenstern, Richard D., William A. Pizer, and Jhih-Shyang Shih. ''Jobs Versus the Environment: An Industry-Level Perspective.'' Journal of Environmental Economics and Management 43 (2002): 412–436; Gray *et al.* (2014), and Ferris, Shadbegian and Wolverton (2014).

[769] Greenstone, M. (2002). ''The Impacts of Environmental Regulations on Industrial Activity: Evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufactures,'' Journal of Political Economy 110(6): 1175–1219 (Docket EPA–HQ–OAR–2014–0827); Walker, Reed. (2011). ''Environmental Regulation and Labor Reallocation.'' American Economic Review: Papers and Proceedings 101(3): 442–447 (Docket EPA–HQ–OAR–2014–0827).

[770] List, J.A., D.L. Millimet, P.G. Fredriksson, and W.W. McHone (2003). ''Effects of Environmental Regulations on Manufacturing Plant Births:

some evidence that this type of geographic relocation may be occurring. Overall, the peer-reviewed literature does not contain evidence that environmental regulation has a large impact on net employment (either negative or positive) in the long run across the whole economy.

Analytic challenges make it very difficult to accurately produce net employment estimates for the whole economy that would appropriately capture the way in which costs, compliance spending, and environmental benefits propagate through the macro-economy. Quantitative estimates are further complicated by the fact that macroeconomic models often have very little sectoral detail and usually assume that the economy is at full employment. EPA is currently in the process of seeking input from an independent expert panel on modeling economy-wide impacts, including employment effects. For more information, see: *https://federalregister.gov/a/2014-02471.*

(2) Employment Impacts in the Motor Vehicle and Parts Manufacturing Sector

This section describes changes in employment in the motor vehicle, trailer, and parts (hence, motor vehicle) manufacturing sectors due to these proposed rules. We focus on the motor vehicle manufacturing sector because it is directly regulated, and because it is likely to bear a substantial share of changes in employment due to these proposed rules. We include discussion of effects on the parts manufacturing sector, because the motor vehicle manufacturing sector can either produce parts internally or buy them from an external supplier, and we do not have estimates of the likely breakdown of effort between the two sectors.

We follow the theoretical structure of Berman and Bui [771] of the impacts of regulation in employment in the regulated sectors. In Berman and Bui's (2001, p. 274–75) theoretical model, as described above, the change in a firm's labor demand arising from a change in regulation is decomposed into two main components: Output and substitution effects.[772] As the output and substitution effects may be both positive, both negative, or some combination, standard neoclassical theory alone does not point to a definitive net effect of regulation on labor demand at regulated firms.

Following the Berman and Bui framework for the impacts of regulation on employment in the regulated sector, we consider two effects for the motor vehicle sector: The output effect and the substitution effect.

(a) The Output Effect

If truck or trailer sales increase, then more people will be required to assemble trucks, trailers, and their components. If truck or trailer sales decrease, employment associated with these activities will decrease. The effects of this proposed rulemaking on HD vehicle sales thus depend on the perceived desirability of the new vehicles. On one hand, this proposed rulemaking will increase truck and trailer costs; by itself, this effect would reduce truck and trailer sales. In addition, while decreases in truck performance would also decrease sales, this program is not expected to have any negative effect on truck performance. On the other hand, this proposed rulemaking will reduce the fuel costs of operating the trucks; by itself, this effect would increase truck sales, especially if potential buyers have an expectation of higher fuel prices. The agencies have not made an estimate of the potential change in truck or trailer sales. However, as discussed in IX. E., the agencies have estimated an increase in vehicle miles traveled (*i.e.,* VMT rebound) due to the reduced operating costs of trucks meeting these proposed standards. Since increased VMT is most likely to be met with more drivers and more trucks, our projection of VMT rebound is suggestive of an increase in vehicle sales and truck driver employment (recognizing that these increases may be partially offset by a decrease in manufacturing and sales for equipment of other modes of transportation such as rail cars or barges).

(b) The Substitution Effect

The output effect, above, measures the effect due to new truck and trailer sales only. The substitution effect includes the impacts due to the changes in technologies needed for vehicles to meet the proposed standards, separate from the effect on output (that is, as though holding output constant). This effect includes both changes in employment due to incorporation of abatement technologies and overall changes in the labor intensity of manufacturing. We present estimates for this effect to provide a sense of the order of magnitude of expected impacts on employment, which we expect to be small in the automotive sector, and to repeat that regulations may have positive as well as negative effects on employment.

One way to estimate this effect, given the cost estimates for complying with the proposed rule, is to use the ratio of workers to each $1 million of expenditures in that sector. The use of these ratios has both advantages and limitations. It is often possible to estimate these ratios for quite specific sectors of the economy: For instance, it is possible to estimate the average number of workers in the motor vehicle body and trailer manufacturing sector per $1 million spent in the sector, rather than use the ratio from another, more aggregated sector, such as motor vehicle manufacturing. As a result, it is not necessary to extrapolate employment ratios from possibly unrelated sectors. On the other hand, these estimates are averages for the sectors, covering all the activities in those sectors; they may not be representative of the labor required when expenditures are required on specific activities, or when manufacturing processes change sufficiently that labor intensity changes. For instance, the ratio for the motor vehicle manufacturing sector represents the ratio for all vehicle manufacturing, not just for emissions reductions associated with compliance activities. In addition, these estimates do not include changes in sectors that supply these sectors, such as steel or electronics producers. They thus may best be viewed as the effects on employment in the motor vehicle sector due to the changes in expenditures in that sector, rather than as an assessment of all employment changes due to these changes in expenditures. In addition, this approach estimates the effects of increased expenditures while holding constant the labor intensity of manufacturing; it does not take into account changes in labor intensity due to changes in the nature of production. This latter effect could either increase or

Evidence from a Propensity Score Matching Estimator.'' The Review of Economics and Statistics 85(4): 944–952 (Docket EPA–HQ–OAR–2014–0827).

771 Berman, E. and L.T.M. Bui (2001). ''Environmental Regulation and Labor Demand: Evidence from the South Coast Air Basin.'' *Journal of Public Economics 79*(2): 265–295 (Docket EPA–HQ–OAR2014–0827).

772 The authors also discuss a third component, the impact of regulation on factor prices, but conclude that this effect is unlikely to be important for large competitive factor markets, such as labor and capital. Morgenstern, Pizer and Shih (2002) use a similar model, but they break the employment effect into three parts: (1) The demand effect; (2) the cost effect; and (3) the factor-shift effect. See Morgenstern, Richard D., William A. Pizer, and Jhih-Shyang Shih. ''Jobs Versus the Environment: An Industry-Level Perspective.'' Journal of Environmental Economics and Management 43 (2002): 412–436 (Docket EPA–HQ–OAR–2014–0827).

decrease the employment impacts estimated here.[773]

Some of the costs of these proposed rules will be spent directly in the motor vehicle manufacturing sector, but it is also likely that some of the costs will be spent in the motor vehicle body and trailer and motor vehicle parts manufacturing sectors. The analysis here draws on estimates of workers per $1 million of expenditures for each of these sectors.

There are several public sources for estimates of employment per $1 million expenditures. The U.S. Bureau of Labor Statistics (BLS) provides its Employment Requirements Matrix (ERM),[774] which provides direct estimates of the employment per $1 million in sales of goods in 202 sectors. The values considered here are for Motor Vehicle Manufacturing (NAICS 3361), Motor Vehicle Body and Trailer Manufacturing (NAICS 3362), and Motor Vehicle Parts Manufacturing (NAICS 3363) for 2012.

The Census Bureau provides the Annual Survey of Manufacturers[775] (ASM), a subset of the Economic Census, based on a sample of establishments; though the Census itself is more complete, it is conducted only every 5 years, while the ASM is annual. Both include more sectoral detail than the BLS ERM: For instance, while the ERM includes the Motor Vehicle Manufacturing sector, the ASM and Economic Census have detail at the 6-digit NAICS code level (*e.g.,* light truck and utility vehicle manufacturing). While the ERM provides direct estimates of employees/$1 million in expenditures, the ASM and Economic Census separately provide number of employees and value of shipments; the direct employment estimates here are the ratio of those values. At this time, the Economic Census values for 2012 (the most recent year) are not fully available; we therefore do not report them, and instead provide the 2011 ASM results (the most recent available). The values reported are for Motor Vehicle Manufacturing (NAICS 3361), Light Truck and Utility Vehicle Manufacturing (NAICS 336112), Heavy Duty Truck Manufacturing (NAICS 33612), Motor Vehicle Body and Trailer manufacturing (NAICS 3362), and Motor Vehicle Parts Manufacturing (NAICS 3363).

Draft RIA Chapter 9.9 provides the details on the values of workers per $1 million in expenditures for the sectors mentioned above. In 2012$, these range from 0.4 workers per $1 million for light truck & utility vehicle manufacturing in the ASM, to 2.8 workers per $1 million in expenditures for Motor Vehicle Body and Trailer Manufacturing in the ASM. These values are then adjusted to remove the employment effects of imports through use of a ratio of domestic production to domestic sales of 0.78.[776]

Over time, the amount of labor needed in the motor vehicle industry has changed: Automation and improved methods have led to significant productivity increases. The BLS ERM, for instance, provided estimates that, in 1993, 1.33 workers in the Motor Vehicle Manufacturing sector were needed per $1 million, but only 0.46 workers by 2012 (in 2005$).[777] Because the ERM is available annually for 1993–2012, we used these data to estimate productivity improvements over time. We then used these productivity estimates to project the ERM through 2027, and to adjust the ASM values for 2011. RIA Chapter 9.9.2.2 provides detail on these calculations.

Finally, to simplify the presentation and give a range of estimates, we compared the projected employment among the 3 sectors for the ERM and ASM, and we provide only the maximum and minimum employment effects estimated for the ERM and the ASM. We provide the range rather than a point estimate because of the inherent difficulties in estimating employment impacts; the range gives an estimate of the expected magnitude. The ERM estimates in the Motor Vehicle Parts Manufacturing Sector are consistently the maximum values. The ERM estimates in the Motor Vehicle Body and Trailer Manufacturing Sector are the minimum values for all years but 2018–2019, when the ASM values for Light Truck and Utility Vehicle Manufacturing provide the minimum values.

Section 0 of the Preamble discusses the vehicle cost estimates developed for these proposed rules. The final step in estimating employment impacts is to multiply costs (in $ millions) by workers per $1 million in costs, to estimate employment impacts in the regulated and parts manufacturing sectors. Increased costs of vehicles and parts would, by itself, and holding labor intensity constant, be expected to increase employment between 2018 and 2027 from none to a few thousand jobs each year.

While we estimate employment impacts, measured in job-years, beginning with program implementation, some of these employment gains may occur earlier as motor vehicle manufacturers and parts suppliers hire staff in anticipation of compliance with the standards. A job-year is a way to calculate the amount of work needed to complete a specific task. For example, a job-year is one year of work for one person.

TABLE IX–37—EMPLOYMENT EFFECTS DUE TO INCREASED COSTS OF VEHICLES AND PARTS (SUBSTITUTION EFFECT), IN JOB-YEARS

Year	Costs (millions of 2012$)	Minimum employment due to substitution effect (ERM estimates, expenditures in the Parts Sector[a])	Maximum employment due to substitution effect (ERM estimates, expenditures in the Body and Trailer Mfg Sector)
2018	116	0	100
2019	113	0	100

[773] As noted above, Morgenstern et al. (2002) separate the effect of holding output constant into two effects: The cost effect, which holds labor intensity constant, and the factor shift effect, which estimates those changes in labor intensity.

[774] *http://www.bls.gov/emp/ep_data_emp_requirements.htm.*

[775] *http://www.census.gov/manufacturing/asm/index.html.*

[776] To estimate the proportion of domestic production affected by the change in sales, we use data from Ward's Automotive Group for total truck production in the U.S. compared to total truck sales in the U.S. For the period 2004–2013, the proportion is 78 percent (Docket EPA–HQ–OAR–2014–0827), ranging from 68 percent (2009) to 83 percent (2012) over that time.

[777] *http://www.bls.gov/emp/ep_data_emp_requirements.htm*; this analysis used data for sectors 81 (Motor Vehicle Manufacturing), 82 (Motor Vehicle Body and Trailer Manufacturing), and 83 (Motor Vehicle Parts Manufacturing) from ''Chain-weighted (2005 dollars) real domestic employment requirements tables.''

TABLE IX–37—EMPLOYMENT EFFECTS DUE TO INCREASED COSTS OF VEHICLES AND PARTS (SUBSTITUTION EFFECT), IN JOB-YEARS—Continued

Year	Costs (millions of 2012$)	Minimum employment due to substitution effect (ERM estimates, expenditures in the Parts Sector [a])	Maximum employment due to substitution effect (ERM estimates, expenditures in the Body and Trailer Mfg Sector)
2020	112	0	100
2021	2,173	300	2,300
2022	2,161	300	2,200
2023	2,224	200	2,100
2024	3,455	300	3,200
2025	3,647	200	3,200
2026	3,736	200	3,100
2027	5,309	200	4,200

Note:
[a] For 2018 and 2019, the minimum employment effects are associated with the ASM's Light Truck and Utility Vehicle Manufacturing sector.

(c) Summary of Employment Effects in the Motor Vehicle Sector

The overall effect of these proposed rules on motor vehicle sector employment depends on the relative magnitude of the output effect and the substitution effect. Because we do not have quantitative estimates of the output effect, and only a partial estimate of the substitution effect, we cannot reach a quantitative estimate of the overall employment effects of these proposed rules on motor vehicle sector employment or even whether the total effect will be positive or negative.

The proposed standards are not expected to provide incentives for manufacturers to shift employment between domestic and foreign production. This is because the proposed standards will apply to vehicles sold in the U.S. regardless of where they are produced. If foreign manufacturers already have increased expertise in satisfying the requirements of the standards, there may be some initial incentive for foreign production, but the opportunity for domestic manufacturers to sell in other markets might increase. To the extent that the requirements of these proposed rules might lead to installation and use of technologies that other countries may seek now or in the future, developing this capacity for domestic production now may provide some additional ability to serve those markets.

(3) Employment Impacts in Other Affected Sectors

(a) Transport and Shipping Sectors

Although not directly regulated by these proposed rules, employment effects in the transport and shipping sector are likely to result from these regulations. If the overall cost of shipping a ton of freight decreases because of increased fuel efficiency (taking into account the increase in upfront purchasing costs), in a perfectly competitive industry some of these costs savings, depending on the relative elasticities of supply and demand, will be passed along to customers. With lower prices, demand for shipping would lead to an increase in demand for truck shipping services (consistent with the VMT rebound effect analysis) and therefore an increase in employment in the truck shipping sector. In addition, if the relative cost of shipping freight via trucks becomes cheaper than shipping by other modes (*e.g.,* rail or barge), then employment in the truck transport industry is likely to increase. If the trucking industry is more labor intensive than other modes, we would expect this effect to lead to an overall increase in employment in the transport and shipping sectors.[778] [779] Such a shift would, however, be at the expense of employment in the sectors that are losing business to trucking. The first effect—a gain due to lower shipping costs—is likely to lead to a net increase in employment. The second effect, due to mode-shifting, may increase employment in trucking, but decrease employment in other shipping sectors (*e.g.,* rail or barge), with the net effects dependent on the labor-intensity of the sectors and the volumes.

(b) Fuel Suppliers

In addition to the effects on the trucking industry and related truck parts sector, these proposed rules will result in reductions in fuel use that lower GHG emissions. Fuel saving, principally reductions in liquid fuels such as diesel and gasoline, will affect employment in the fuel suppliers industry sectors, principally the Petroleum Refinery sector.

Section IX. C. of this Preamble provides estimates of the effects of these proposed standards on expected fuel consumption. While reduced fuel consumption represents savings for purchasers of fuel, it also represents a loss in value of output for the petroleum refinery industry, which will result in reduced sectoral employment. Because this sector is material-intensive, the employment effect is not expected to be large.[780]

(c) Fuel Savings

As a result of this proposed rulemaking, it is anticipated that trucking firms will experience fuel savings. Fuel savings lower the costs of transportation goods and services. In a competitive market, some of the fuel savings that initially accrue to trucking firms are likely to be passed along as lower transportation costs that, in turn, could result in lower prices for final goods and services. Some of the savings might also be retained by firms for investments or for distributions to firm owners. Again, how much accrues to customers versus firm owners will depend on the relative elasticities of supply and demand. Regardless, the savings will accrue to some segment of consumers: Either owners of trucking firms or the general public, and the

[778] American Transportation Research Institute, ''An Analysis of the Operational Costs of Trucking: 2011 Update.'' *See http://www.atri-online.org/research/results/Op_Costs_2011_Update_one_page_summary.pdf.*

[779] Association of American Railroads, ''All Inclusive Index and Rail Adjustment Factor.'' June 3, 2011. *See http://www.aar.org/~/media/aar/RailCostIndexes/AAR-RCAF-2011-Q3.ashx.*

[780] In the 2012 BLS ERM cited above, the Petroleum and Coal Products Manufacturing sector has a ratio of workers per $1 million of 0.242, lower than all but two of the 181 sectors with non-zero employment per $1 million.

effect will be increased spending by consumers in other sectors of the economy, creating jobs in a diverse set of sectors, including retail and service industries.

As described in Section IX. C. (2) the value of fuel savings from this proposed rulemaking is projected to be $15.1 billion (2012$) in 2027, according to Table IX–6. If all those savings are spent, the fuel savings will stimulate increased employment in the economy through those expenditures. If the fuel savings accrue primarily to firm owners, they may either reinvest the money or take it as profit. Reinvesting the money in firm operations could increase employment directly. If they take the money as profit, to the extent that these owners are wealthier than the general public, they may spend less of the savings, and the resulting employment impacts would be smaller than if the savings went to the public. Thus, while fuel savings are expected to decrease employment in the refinery sector, they are expected to increase employment through increased consumer expenditures.

(4) Summary of Employment Impacts

The primary employment effects of these rules are expected to be found throughout several key sectors: Truck and engine manufacturers, the trucking industry, truck parts manufacturing, fuel production, and consumers. These rules initially takes effect in model year 2018, a time period sufficiently far in the future that the unemployment rate at that time is unknowable. In an economy with full employment, the primary employment effect of a rulemaking is likely to be to move employment from one sector to another, rather than to increase or decrease employment. For that reason, we focus our partial quantitative analysis on employment in the regulated sector, to examine the impacts on that sector directly. We discuss the likely direction of other impacts in the regulated sector as well as in other directly related sectors, but we do not quantify those impacts, because they are more difficult to quantify with reasonable accuracy, particularly so far into the future.

For the regulated sector, we have not quantified the output effect. The substitution effect is associated with potential increased employment from none to a few thousand jobs per year between 2018 and 2027, depending on the share of employment impacts in the affected sectors (Motor Vehicle Manufacturing, Motor Vehicle Body and Trailer Manufacturing, and Motor Vehicle Parts Manufacturing). These estimates do not include potential changes, either greater or less, in labor intensity of production. As mentioned above, some of these job gains may occur earlier as auto manufacturers and parts suppliers hire staff to prepare to comply with the standard.

Lower prices for shipping are expected to lead to an increase in demand for truck shipping services and, therefore, an increase in employment in that sector, though this effect may be offset somewhat by changes in employment in other shipping sectors. Reduced fuel production implies less employment in the fuel provision sectors. Finally, any net cost savings would be expected to be passed along to some segment of consumers: Either the general public or the owners of trucking firms, who are expected then to increase employment through their expenditures. Under conditions of full employment, any changes in employment levels in the regulated sector due to this program are mostly expected to be offset by changes in employment in other sectors.

M. Cost of Ownership and Payback Analysis

This section examines the economic impacts of the Phase 2 proposed standards from the perspective of buyers, operators, and subsequent owners of new HD vehicles, first in the aggregate and then at the level of individual purchasers of different types of vehicles. In each case, the analysis assumes that HD vehicle manufacturers are able to recover their costs for improving fuel efficiency—including direct technology outlays, indirect costs, and normal profits on any additional capital investments—by charging higher prices to HD vehicle buyers. As summarized below, HDV buyers in the aggregate would experience substantial savings in fuel costs that would more than offset higher initial outlays to buy more fuel-efficient new vehicles.

Table IX–38 reports aggregate benefits and costs to buyers and operators of new HD vehicles for the Preferred Alternative using Method A. The table reports economic impacts on buyers using only the 7 percent discount rate, since that rate is intended to represent the opportunity cost of capital that HD vehicle buyers and users must divert from other investment opportunities to purchase more costly vehicles. As it shows, fuel savings and the other benefits from increased fuel efficiency—savings from less frequent refueling and benefits from additional truck use—far outweigh the higher costs to buyers of new HD vehicles. As a consequence, buyers, operators, and subsequent owners of HD vehicles subject to the Phase 2 standards are together projected to experience large economic gains under the Preferred Alternative. It should be noted that, because the original buyers may not hold the vehicles for their lifetimes, and because those who own or operate the vehicles may not pay for the fuel, these benefits and costs do not necessarily represent benefits and costs to identifiable individuals.

As Table IX–38 shows, the agencies have estimated the increased costs for maintenance of the new technologies that HD vehicle manufacturers would employ to decrease fuel consumption, and these costs are included together with those for purchasing more fuel-efficient vehicles. Manufacturers' efforts to comply with the Phase 2 standards could also result in changes to vehicle performance and capacity for certain vehicles. For example, reducing the mass of HD vehicles in order to improve fuel efficiency could be used to improve their load-carrying capabilities, while some engine technologies and aerodynamic modifications could reduce payload capacity. The agencies request comment on possible changes to vehicle performance and load-carrying capacity as a result of the proposal along with supporting information.

TABLE IX–38—MY 2018–2029 LIFETIME AGGREGATE IMPACTS OF THE PREFERRED ALTERNATIVE ON ALL HD VEHICLE BUYERS AND OPERATORS USING METHOD A

[Billions of 2012$, Discounted at 7%] [a]

	Baseline 1a	Baseline 1b
Vehicle costs	17.1	16.8
Maintenance costs	0.6	0.6
Total costs to HD vehicle buyers	17.7	17.4

TABLE IX–38—MY 2018–2029 LIFETIME AGGREGATE IMPACTS OF THE PREFERRED ALTERNATIVE ON ALL HD VEHICLE BUYERS AND OPERATORS USING METHOD A—Continued

[Billions of 2012$, Discounted at 7%] [a]

	Baseline 1a	Baseline 1b
Fuel savings [b]		
(valued at retail prices)	104.6	99.1
Refueling benefits	1.6	1.5
Increased travel benefits	8.4	8.2
Total benefits to HD vehicle buyers/operators	114.7	108.9
Net benefits to HD vehicle buyers/operators [c]	97.0	91.5

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Fuel savings includes fuel consumed during additional rebound driving.

[c] Net benefits shown do not include benefits associated with carbon or other co-pollutant emission reductions, accidents/congestion/noise impacts, energy security, etc.

Table IX–38 shows aggregate benefits and costs to buyers and operators of new HD vehicles for the Preferred Alternative using Method B, again for only the 7 percent discount rate. As it shows, fuel savings and the other benefits outweigh the higher prices and added maintenance costs that buyers and operators of new HD vehicles pay, so they are again expected to experience large economic gains from the Preferred Alternative. Again, because the original buyers may not hold the vehicles for their lifetimes, and because those who own or operate the vehicles may not pay for the fuel, these benefits and costs do not necessarily represent benefits and costs to identifiable individuals.

TABLE IX–39 MY 2018–2029 LIFETIME AGGREGATE IMPACTS OF THE PREFERRED ALTERNATIVE ON ALL HD VEHICLE BUYERS AND OPERATORS USING METHOD B

[Billions of 2012$, Discounted at 7%] [a]

	Baseline 1b
Vehicle costs	16.6
Maintenance costs	0.6
Total costs to HD vehicle buyers	17.2
Fuel savings [b] (valued at retail prices)	100.1
Refueling benefits	1.6
Increased travel benefits	8.2
Total benefits to HD vehicle buyers/operators	109.9
Net benefits to HD vehicle buyers/operators [c]	92.7

Notes:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

[b] Fuel savings includes fuel consumed during additional rebound driving.

[c] Net benefits shown do not include benefits associated with carbon or other co-pollutant emission reductions, accidents/congestion/noise impacts, energy security, etc.

It is also useful to examine the cost of purchasing and owning a new vehicle that complies with the Phase 2 standards and its payback period—the point at which cumulative savings from lower fuel expenditures outpace increased vehicle costs. For example, a new MY2027 tractor is estimated to cost roughly $11,684 more (on average, or roughly 12 percent of a typical $100,000 reference case tractor) due to the addition of new GHG reducing/fuel consumption improving technology. This new technology would result in lower fuel consumption and, therefore, reduced fuel expenditures. But how many months or years would pass before the reduced fuel expenditures would surpass the increased upfront costs?

Table IX–40 presents the discounted annual increased vehicle costs and fuel savings associated with owning a new MY2027 HD pickup or van using both 3 percent and 7 percent discount rates. Table IX–41 and Table IX–42 show the same information for a MY2027 vocational vehicle and a tractor/trailer, respectively. These comparisons include sales taxes, excise taxes (for vocational and tractor/trailer) and increased insurance expenditures on the higher value vehicles, as well as maintenance costs associated with replacement of lower rolling resistance tires throughout the lifetimes of affected vehicles. Importantly, the values behind the tables in this payback analysis do not include rebound miles driven and/or rebound gallons consumed. Instead, the tables use reference case miles driven combined with policy case fuel consumption. We detail these input metrics in Chapter 7 of the draft RIA.

The fuel expenditure column uses retail fuel prices specific to gasoline and diesel fuel as projected in AEO2014.[781] This payback analysis does not include other impacts, such as reduced refueling events, the value of driving potential rebound miles, or noise, congestion and accidents. We use retail fuel prices and

[781] U.S. Energy Information Administration, Annual Energy Outlook 2014, Early Release; Report Number DOE/EIA–0383ER(2014), December 16, 2013.

exclude these other private and social impacts because the analysis is intended to focus on those factors that are most important to buyers when considering a new vehicle purchase, and to include only those factors that have clear dollar impacts on HD vehicle buyers.

As shown, payback would occur in the 3rd year of ownership for HD pickups and vans (the first year where cumulative net costs turn negative), in the 5th year for vocational vehicles (at a 3 percent discount rate, 6th year at a 7 percent discount rate) and early in the 2nd year for tractor/trailers. Note that each table reflects the average vehicle and reflects proper weighting of fuel consumption/costs (gasoline vs. diesel). We request comment and supporting data on all aspects of our payback analysis.

TABLE IX–40—DISCOUNTED ANNUAL INCREMENTAL EXPENDITURES FOR A MY 2027 HD PICKUP OR VAN USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[2012$] [a]

Age in years	3% Discount rate				7% Discount rate			
	Vehicle [b]	Maint [c]	Fuel [d]	Cumulative Net	Vehicle [b]	Maint [c]	Fuel [d]	Cumulative net
1	$1,587	$4	−$759	$832	$1,558	$3	−$745	$817
2	25	3	−734	126	23	3	−694	150
3	23	3	−714	−561	21	3	−649	−476
4	22	3	−693	−1,229	19	3	−606	−1,060
5	20	3	−651	−1,857	17	2	−549	−1,590
6	19	3	−611	−2,446	15	2	−496	−2,067
7	18	2	−571	−2,997	14	2	−446	−2,497
8	16	2	−536	−3,514	12	2	−403	−2,886

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.
[b] Includes new technology costs, insurance costs and sales taxes.
[c] Maintenance costs.
[d] Uses AEO2014 retail fuel prices.

TABLE IX–41—DISCOUNTED ANNUAL INCREMENTAL EXPENDITURES FOR A MY 2027 VOCATIONAL VEHICLE USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[2012$] [a]

Age in years	3% Discount rate				7% Discount rate			
	Vehicle [b]	Maint [c]	Fuel [d]	Cumulative Net	Vehicle [b]	Maint [c]	Fuel [d]	Cumulative net
1	$3,998	$10	−$965	$3,043	$3,924	$10	−$947	$2,987
2	63	9	−937	2,178	59	9	−885	2,169
3	59	9	−914	1,331	53	8	−832	1,399
4	55	9	−891	504	48	8	−780	675
5	51	8	−829	−265	43	7	−699	27
6	48	7	−771	−981	39	6	−625	−554
7	45	7	−716	−1,645	35	5	−559	−1,073
8	42	6	−667	−2,264	31	5	−501	−1,538

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.
[b] Includes new technology costs, insurance costs, excise and sales taxes.
[c] Maintenance costs.
[d] Uses AEO2014 retail fuel prices.

TABLE IX–42—DISCOUNTED ANNUAL INCREMENTAL EXPENDITURES FOR A MY 2027 TRACTOR/TRAILER USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE

[2012$] [a]

Age in years	3% Discount rate				7% Discount rate			
	Vehicle [b]	Maint [c]	Fuel [d]	Cumulative Net	Vehicle [b]	Maint [c]	Fuel [d]	Cumulative Net
1	$15,194	$48	−$14,649	$593	$14,914	$47	−$14,379	$582
2	238	46	−14,204	−13,327	225	43	−13,421	−12,571
3	223	44	−13,809	−26,869	203	40	−12,561	−24,889
4	209	42	−13,416	−40,034	183	37	−11,746	−36,415
5	195	39	−12,391	−52,191	164	33	−10,443	−46,661
6	182	35	−11,411	−63,385	148	29	−9,258	−55,743
7	170	32	−10,511	−73,694	133	25	−8,209	−63,794

TABLE IX–42—DISCOUNTED ANNUAL INCREMENTAL EXPENDITURES FOR A MY 2027 TRACTOR/TRAILER USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE—Continued

[2012$] [a]

Age in years	3% Discount rate				7% Discount rate			
	Vehicle [b]	Maint [c]	Fuel [d]	Cumulative Net	Vehicle [b]	Maint [c]	Fuel [d]	Cumulative Net
8	158	29	−9,704	−83,211	119	22	−7,295	−70,949

Notes:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.
[b] Includes new technology costs, insurance costs, excise and sales taxes.
[c] Maintenance costs.
[d] Uses AEO2014 retail fuel prices.

N. Safety Impacts

(1) Summary of Supporting HD Vehicle Safety Research

NHTSA and EPA considered the potential safety impact of technologies that improve HD vehicle fuel efficiency and GHG emissions as part of the assessment of regulatory alternatives. The safety assessment of the technologies in this proposal was informed by two NAS reports, an analysis of safety effects of HD pickups and vans using estimates from the DOT report on the effect of mass reduction and vehicle size on safety, and agency-sponsored safety testing and research. A summary of the literature and work considered by the agencies follows.

(2) National Academy of Sciences HD Phase 1 and Phase 2 Reports

As required by EISA, the National Research Council has conducted two studies of the technologies and approaches for reducing the fuel consumption of medium- and heavy-duty vehicles. The first was documented in a report issued in 2010, ''Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles'' (''NAS Report''). The second was documented in a report issued in 2014, ''Reducing the Fuel Consumption and Greenhouse Gas Emissions of Medium- and Heavy-Duty Vehicles, Phase Two-First Report'' (''NAS HD Phase 2 First Report''). While the reports primarily focused on reducing vehicle fuel consumption and emissions through technology application, and examined potential regulatory frameworks, both reports additionally contain findings and recommendations on safety. In developing this proposal, the agencies carefully considered both of the reports' findings related to safety. Some of the reports' key findings related to safety follow.

NAS commented that idle reduction strategies in actual can be sophisticated to provide for the safety of the driver in hot and cold weather.[782] The agencies considered this comment in our approach for idle reduction technologies and allow override provisions, as discussed in Section III. Override is allowed if the external ambient temperature reaches a level below which or above which the cabin temperature cannot be maintained within reasonable heat or cold exposure threshold limit values for the health and safety of the operator (not merely comfort). NAS commented extensively on the recent emergence of natural gas (NG) as a viable technology option for commercial vehicles, but alluded to the existence of uncertainties regarding its safety. The committee found that while the public crash databases do not contain information on vehicle fuel type, the existing information indicates that the crash-related safety risk for NG storage on vehicles does not appear to be appreciably different from diesel fuel risks. The committee also found that while there are two existing SAE-recommended practice standards for NG-powered HD vehicles, the industry could benefit from best practice directives to minimize crash risks for NG fuel tanks, such as on shielding to prevent punctures during crashes. As a final point, NAS stated that manufacturers and operators have a great incentive to prevent possible NG leakage from a vehicle fuel system because it would be a significant safety concern and reduce vehicle range. No recommendations were made for additional Federal safety regulations for these vehicles. In response, the agencies have reviewed and discuss the existing NG vehicle standards and best practices cited by NAS in Section XI.

In the NAS Committee's Phase 1 report, the Committee commented that aerodynamic fairings detaching from trucks on the road was a potential safety issue. However, the Phase 2 interim report stated that ''Anecdotal information gained during the observations of on-road trailers indicates a few skirts badly damaged or missing from one side. The skirt manufacturers report no safety concerns (such as side skirts falling off) and little maintenance needed.''

The NAS report also identified the link between tire inflation and condition and vehicle stopping distance and handling, which impacts overall safety. The committee found that tire pressure monitoring systems and automatic tire inflation systems are being adopted by fleets at an increasing rate. However, the committee noted that there are no standards for performance, display, and system validation. The committee recommended that NHTSA issue a white paper on the minimum performance of tire pressure systems from a safety perspective.

The agencies considered the safety findings in both NAS reports in developing this proposal and conducted additional research on safety to further examine information and findings of the reports.

(3) DOT CAFE Model HD Pickup and Van Safety Analysis

This analysis considered the potential effects on crash safety of the technologies manufacturers may apply to their HD pickups and vans to meet each of the regulatory alternatives evaluated. NHTSA research has shown that vehicle mass reduction affects overall societal fatalities associated with crashes and, most relevant to this proposal, that mass reduction in heavier light- and medium-duty vehicles has an overall beneficial effect on societal fatalities. Reducing the mass of a heavier vehicle involved in a crash with another vehicle(s) makes it less likely that there will be fatalities among the occupants of the other vehicles. In addition to the effects of mass reduction, the analysis anticipates that the proposed standards, by reducing the

[782] *Id.*, p. 33.

cost of driving HD pickups and vans, would lead to increased travel by these vehicles and, therefore, more crashes involving these vehicles. The Method A analysis considers overall impacts from both of these factors, using a methodology similar to NHTSA's analyses for the MYs 2017–2025 CAFE and GHG emission standards.

The Method A analysis includes estimates of the extent to which HD pickups and vans produced during MYs 2014–2030 may be involved in fatal crashes, considering the mass, survival, and mileage accumulation of these vehicles, taking into account changes in mass and mileage accumulation under each regulatory alternative. These calculations make use of the same coefficients applied to light trucks in the MYs 2017–2025 CAFE rulemaking analysis. As discussed above, vehicle miles traveled may increase due to the fuel economy rebound effect, resulting from improvements in vehicle fuel efficiency and cost of fuel, as well as the assumed future growth in average vehicle use. Increases in total lifetime mileage increase exposure to vehicle crashes, including those that result in fatalities. Consequently, the modeling system computes total fatalities attributed to vehicle use for vehicles of a given model year based on safety class and weight threshold. These calculations also include a term that accounts for the fact that vehicles involved in future crashes will be certified to more stringent safety standards than those involved with past crashes upon which the base rates of involvement in fatal crashes were estimated. Since the use of mass reducing technology is present within the model, safety impacts may also be observed whenever a vehicle's base weight decreases. Thus, in addition to computing total fatalities related to vehicle use, the modeling system also estimates changes in fatalities due to reduction in a vehicle's curb weight.

The total fatalities attributed to vehicle use and vehicle weight change for vehicles of a given model year are then summed. Lastly, total fatalities occurring within the industry in a given model year are accumulated across all vehicles. In addition to using inputs to estimate the future involvement of modeled vehicles in crashes involving fatalities, the model also applies inputs defining other accident-related externalities estimated on a dollar per mile basis. For vehicles above 4,594 lbs—*i.e.,* the majority of the HD pickup and van fleet—mass reduction is estimated to reduce the net incidence of highway fatalities by 0.34 percent per 100 lbs of removed curb weight. For the few HD pickups and vans below 4,594 lbs, mass reduction is estimated to increase the net incidence of highway fatalities by 0.52 percent per 100 lbs. Because there are many more HD pickups and vans above 4,594 lbs than below 4,594 lbs, the overall effect of mass reduction in the segment is estimated to reduce the incidence of highway fatalities. The estimated increase in vehicle miles traveled due to the fuel economy rebound effect is estimated to increase exposure to vehicle crashes and offset these reductions.

(4) Volpe Research on MD/HD Fuel Efficiency Technologies

The 2010 National Research Council report ''Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles'' recommended that NHTSA perform a thorough safety analysis to identify and evaluate potential safety issues with fuel efficiency-improving technologies. The Department of Transportation Volpe Center's 2015 report titled ''Review and Analysis of Potential Safety Impacts and Regulatory Barriers to Fuel Efficiency Technologies and Alternative Fuels in Medium- and Heavy-Duty Vehicles'' summarizes research and analysis findings on potential safety issues associated with both the diverse alternative fuels (natural gas-CNG and LNG, propane, biodiesel, and power train electrification), and the specific FE technologies recently adopted by the MD/HDV fleets.[783] These include Intelligent Transportation Systems (ITS) and telematics, speed limiters, idle reduction devices, tire technologies (single-wide tires, and tire pressure monitoring systems-TPMS and Automated Tire Inflation Systems-ATIS), aerodynamic components, vehicle light-weighting materials, and Long Combination Vehicles (LCVs).

Chapter 1 provides an overview of the study's rationale, background, and key objective, namely, to identify the technical and operational/behavioral safety benefits and disbenefits of MD/HDVs equipped with FE technologies and using emerging alternative fuels (AFs). Recent MD/HDV national fleet crash safety statistical averages are also provided for context, although no information exists in crash reports relating to specific vehicle FE technologies and fuels. (NHTSA/FARS and FMCSA/CSA databases do not include detailed information on vehicle fuel economy technologies, since the state crash report forms are not coded down to an individual fuel economy technology level).

[783] Brecher, A., Epstein, A.K., & Breck, A. (2015, June). *Review and analysis of potential safety impacts of and regulatory barriers to fuel efficiency technologies and alternative fuels in medium- and heavy-duty vehicles.* (Report No. DOT HS 812 159). Washington, DC: National Highway Traffic Safety Administration.

Chapters 2 and 3 are organized by clusters of functionally-related FE technologies for vehicles and trailers (*e.g.,* tire systems, ITS, light-weighting materials, and aerodynamic systems) and alternative fuels, which are described and their respective associated potential safety issues are discussed. Chapter 2 summarizes the findings from a comprehensive review of available technical and trade literature and Internet sources regarding the benefits, potential safety hazards, and the applicable safety regulations and standards for deployed FE technologies and alternative fuels. Chapter 2 safety-relevant fuel-specific findings include:

- Both CNG- and LNG-powered vehicles present potential hazards, and call for well-known engineering and process controls to assure safe operability and crashworthiness. However, based on the reported incident rates of NGVs and the experiences of adopting fleets, it appears that NGVs can be operated at least as safely as diesel MD/HDVs.
- There are no safety contraindications to the large scale fleet adoption of CNG or LNG fueled heavy duty trucks and buses, and there is ample experience with the safe operation of large public transit fleets. Voluntary industry standards and best practices suffice for safety assurance, though improved training of CMV operators and maintenance staff in natural gas safety of equipment and operating procedures is needed.
- Observing CNG and LNG fuel system and maintenance facility standards, coupled with sound design, manufacture, and inspection of natural gas storage tanks will further reduce the potential for leaks, tank ruptures, fires, and explosions.
- Biodiesel blends used as drop-in fuels have presented some operational safety concerns dependent on blending fraction, such as material compatibility, bio-fouling sludge accumulation, or cold-weather gelling. However, best practices for biodiesel storage, and improved gaskets and seals that are biodiesel resistant, combined with regular maintenance and leak inspection schedules for the fuel lines and components enable the safe use of biodiesel in newer MD/HDVs.
- Propane (LPG, or autogas) presents well-known hazards including ignition (due to leaks or crash) that are

preventable by using Overfill Prevention Devices (OPDs), which supplement the automatic stop-fill system on the fueling station side, and pressure release devices (PRDs). Established best practices and safety codes (*e.g.,* NFPA) have proven that propane fueled MD/HDVs can be as operationally safe as the conventionally-fueled counterparts.

• As the market penetration of hybrid and electric drivetrain accelerates, and as the capacity and reliability of lithium ion batteries used in Rechargeable Energy Storage Systems (RESS) improve, associated potential safety hazards (*e.g.,* electrocution from stranded energy, thermal runaway leading to battery fire) have become well understood, preventable, and manageable. Existing and emerging industry technical and safety voluntary standards, applicable NHTSA regulations and guidance, and the growing experience with the operation of hybrid and electric MD/HDVs will enable the safe operation and large-scale adoption of safer and more efficient power-train electrification technologies.

The safety findings from literature review pertaining to the specific FE technologies implemented to date in the MD/HDV fleet include:

• Telematics—integrating on-board sensors, video, and audio alerts for MD/HDV drivers—offer potential improvements in both driver safety performance and fuel efficiency. Both camera and non-camera based telematics setups are currently integrated with available crash avoidance systems (such as ESC, RSC, LDWS, etc.) and appear to be well accepted by MD/HDV fleet drivers.

• Both experience abroad and the cited US studies of trucks equipped with active speed limiters indicated a safety benefit, as measured by up to 50 percent reduced crash rates, in addition to fuel savings and other benefits, with good CMV driver acceptance. Any negative aspects were small and avoidable if all the speed limitation devices were set to the same speed, so there would be less need for overtaking at highway speeds.

• No literature reports of adverse safety impacts were found regarding implementation of on-board idle-reduction technologies in MD/HDVs (such as automatic start-stop, direct-fired heaters, and APUs).

• There was no clear consensus from the literature regarding the relative crash rates and highway safety impacts of LCVs, due to lack of sufficient data and controls and inconsistent study methodologies. Recent safety evaluations of LCVs and ongoing MAP–21 mandated studies will clarify and quantify this issue.

• Tire technologies for FE (including ATIS, TPMS, LRR and single-wide tires) literature raised potential safety concerns regarding lower stability or loss of control, *e.g.,* when tire pressure is uneven or a single wide tire blows out on the highway. However, systems such as automated tire monitoring systems and stability enhancing electronic systems (ABS, ESC, RSC) may compensate and mitigate any adverse safety impacts.

• Aerodynamic technologies that offer significant fuel savings have raised potential concerns about vehicle damage or injury in case of detached fairings or skirts, although there were no documented incidents of this type in the literature.

• Some light weighting materials may pose some fire safety and crashworthiness hazards, depending on their performance in structural or other vehicle subsystem applications (chassis, power-train, crash box or safety cage). Some composites (fiberglass, plastics, CFRC, foams) may become brittle on impact or due to weathering from UV exposure or extreme cold. Industry has developed advanced, high performance lightweight material options tailored to their automotive applications, *e.g.,* thermoplastics resistant to UV and weathering. No examples of such lightweight material failures on MD/HDVs were identified in the literature.

Chapter 3 provides complementary inputs on the potential safety issues associated with FE technologies and alternative fuels obtained from Subject Matter Experts (SMEs). The broad cross-section of SMEs consulted had experience with the operation of ''green'' truck and bus fleets, were Federal program managers, or were industry developers of FE systems for MD/HDVs. Safety concerns raised by the SMEs can be prevented or mitigated by complying with applicable regulations and safety standards and best practices, and are being addressed by evolving technologies, such as electronic collision prevention devices. Although SMEs raised some safety concerns, their experience indicates that system- or fuel-specific hazards can be prevented or mitigated by observing applicable industry standards, and by training managers, operators and maintenance staff in safety best practices. Specific safety concerns raised by SMEs based on their experience included:

• Alternative fuels did not raise major safety concerns, but generally required better education and training of staff and operators. There was a concern expressed regarding high pressure (4000 psi) CNG cylinders that could potentially explode in a crash scenario or if otherwise ruptured. However, aging CNG fuel tank safety can be assured by enforcing regulations such as FMVSS No. 304, and by periodic inspection and end-of-life disposal and replacement. A propane truck fleet manager stated that the fuel was as safe as or safer than gasoline, and reported no safety issues with the company's propane, nor with hybrid gasoline-electric trucks. OEMs of drivetrain hybridization and electrification systems, including advanced Lithium Ion batteries for RESS, indicated that they undergo multiple safety tests and are designed with fail-safes for various misuse and abuse scenarios. Integration of hybrid components downstream by bodybuilders in retrofits, as opposed to new vehicles, was deemed a potential safety risk. Another potential safety concern raised was the uncertain battery lifetime due to variability of climate, duty-cycles, and aging. Without state-of-charge indicators, this could conceivably leave vehicles underpowered or stranded if the battery degrades and is not serviced or replaced in a timely manner.

• ITS and telematics raised no safety concerns; on the contrary, fleet managers stated that ''efficient drivers are safer drivers.'' Monitoring and recording of driver behavior, combined with coaching, appeared to reduce distracted and aggressive driving and provided significant FE and safety benefits.

• A wide-base single tire safety concern was the decrease in tire redundancy in case of a tire blowout at highway speeds. For LRRs, a concern was that they could negatively affect truck stopping distance and stability control.

• A speed-limiter safety concern was related to scenarios when such trucks pass other vehicles on the highway instead of staying in the right-hand lane behind other vehicles. By combining speed limiters with driver training programs, overall truck safety could actually improve, as shown by international practice.

• Aerodynamic systems' safety performance to date was satisfactory, with no instances of on-road detaching. However, covering underside or other components with aerodynamic fairings can make them harder to inspect, such as worn lugs, CNG relief valve shrouds, wheel covers, and certain fairings. Drivers and inspectors need to be able to see through wheel covers and to be able to access lug nuts through them. These covers must also be durable to withstand frequent road abuse.

- For lightweighting materials, the safety concern raised was lower crashworthiness (debonding or brittle fracture on impact) and the potential for decreased survivability in vehicle fires depending on the specific material choice and its application.

The key finding from the literature review and SME interviews is that there appear to be no major safety hazards preventing the adoption of FE technologies, or the increased use of alternative fuels and vehicle electrification. In view of the scarcity of hard data currently available on actual highway crashes that can be directly or causally attributed to adoption of FE technologies and/or alternative fuels by MD/HDVs, and the limited experience with commercial truck and transit bus fleets operations equipped with these technologies, it was not possible to perform a quantitative, probabilistic risk assessment, or even a semi-quantitative preliminary hazard analysis (PHA). Chapter 4 employs a deterministic scenario-based hazard analysis of potential crash or other safety concerns identified from the literature review or raised by subject matter experts (SMEs) interviewed (*e.g.,* interfaces with charging or refueling infrastructure). For each specific hazard scenario discussed, the recommended prevention or mitigation options, including compliance with applicable NHTSA or FMCSA regulations, and voluntary industry standards and best practices are identified, along with FE technology or fuel-specific operator training. SMEs safety concerns identified in Sec 3.3 were complemented with actual incidents, and developed into the hazard scenarios analyzed in Chapter 4.

The scenario-based deterministic hazard analysis reflected not only the literature findings and SMEs' safety concerns, but also real truck or bus mishaps that have occurred in the past. Key hazard analysis scenarios included: CNG-fueled truck and bus vehicle fires or explosions due to tank rupture, when pressurized fuel tanks were degraded due to aging or when PRDs failed; LNG truck crashes leading to fires, or LNG refueling-related mishaps; the flammability or brittle fracture issues related to lightweighting materials in crashes; reduced safety performance for either LRR or wide-base tires; highway pile-ups when LCVs attempt to pass at highway speeds; aerodynamic components detaching while the vehicle traveled on a busy highway or urban roadway; and fires resulting in overheated lithium ion batteries in electric or hybrid buses. These hypothetical worst case scenarios appear to be preventable or able to be mitigated by observing safety regulations and voluntary standards, or with engineering and operational best practices.

Chapter 5 reviews and discusses the existing federal and state regulatory framework for safely operating MD/HDVs equipped with FE technologies or powered by alternative fuels. The review identifies potential regulatory barriers to their large-scale deployment in the national fleet that could delay achievement of desired fuel consumption and environmental benefits, while ensuring equal or better safety performance.

Chapter 6 summarizes the major findings and recommendations of this preliminary safety analysis of fuel efficiency technologies and alternative fuels adopted by MD/HDVs. The scenario-based hazard analysis, based on the literature review and experts' inputs, indicates that MD/HDVs equipped with advanced FE technologies and/or using alternative fuels have manageable potentially adverse safety impacts. The findings suggest that the potential safety hazards identified during operation, maintenance, and crash scenarios can be prevented or mitigated by complying with safety regulations and voluntary standards and industry best practices. The study also did not identify any major regulatory barriers to rapid adoption of FE technologies and alternative fuels by the MD/HDV fleet.

(5) Oak Ridge National Laboratory (ORNL) Research on Low Rolling Resistance Truck Tires

DOT's Federal Motor Carrier Safety Administration and NHTSA sponsored a test program conducted by Oak Ridge National Laboratory to explore the effects of tire rolling resistance levels on Class 8 tractor-trailer stopping distance performance over a range of loading and surface conditions. The objective was to determine whether there is a relationship between tire rolling resistance and stopping distance for vehicles of this type. The overall results of this research suggest that tire rolling resistance is not a reliable indicator of Class 8 tractor-trailer stopping distance. The correlation coefficients (R2 values) for linear regressions of wet and dry stopping distance versus overall vehicle rolling resistance values did not meet the minimum threshold for statistical significance for any of the test conditions. Correlation between CRR and stopping distance was found to be negligible for the dry tests for both loading conditions. While correlation was higher for the wet testing (showing a slight trend in which lower CRRs correspond to longer stopping distances), it still did not meet the minimum threshold for statistical significance. In terms of compliance with Federal safety standards, it was found that the stopping distance performance of the vehicle with the four tire sets studied in this research (with estimated tractor CRRs which varied by 33 percent), were well under the FMVSS No. 121 stopping distance requirements.

(6) Additional Safety Considerations

The agencies' considered the Organic Rankine Cycle waste heat recovery (WHR) as a fuel saving technology in the rulemaking timeframe. The basic approach of these systems is to use engine waste heat from multiple sources to evaporate a working fluid through a heat exchanger, which is then passed through a turbine or equivalent expander to create mechanical or electrical power. The working fluid is then condensed as it passes through a heat exchanger and returns to back to the fluid tank, and pulled back to the flow circuit through a pump to continue the cycle. Despite the promising performance of pre-prototype WHR systems, manufacturers have not yet arrived at a consensus on which working fluid(s) to be used in WHR systems to balance concerns regarding performance, global warming potential (GWP), and safety. Current working fluids have a high GWP (conventional refrigerant), are expensive (low GWP refrigerant), are hazardous (ammonia, etc.), are flammable (ethanol/methanol), or can freeze (water). One of the challenges is determining how to seal the working fluid properly under the vacuum condition with high temperature to avoid safety issues for flammable/hazardous working fluids. Because of these challenges, choosing a working fluid will be an important factor for system safety, efficiency, and overall production viability. The agencies believe manufacturers will require additional time and development effort to assure that a working fluid that is both appropriate, given the noted challenges, and has a low GWP for use in waste heat recovery systems. Based on this and other factors, the analysis for the Preferred Alternative assumes that WHR would not achieve a significant market penetration for diesel tractor engines (*i.e.,* greater than 5 percent) until 2027, which would provide time for these considerations to be addressed. The agencies assume no use of this technology in the HD pickups and vans and vocational vehicle segments.

(7) The Agencies' Assessment of Potential Safety Impacts

NHTSA and EPA considered the potential safety impact of technologies that improve HD vehicle fuel efficiency and GHG emissions as part of the assessment of regulatory alternatives. The safety assessment of the technologies in this proposal was informed by two NAS reports, an analysis of safety effects of HD pickups and vans using estimates from the DOT report on the effect of mass reduction and vehicle size on safety, and agency-sponsored safety testing and research. The agencies considered safety from the perspective of both direct effects and indirect effects.

In terms of direct effects on vehicle safety, research from NAS and Volpe, and direct testing of technologies like the ORNL tire work, indicate that there are no major safety hazards associated with the adoption of technologies that improve HD vehicle fuel efficiency and GHG emissions or the increased use of alternative fuels and vehicle electrification. The findings suggest that the potential safety hazards identified during operation, maintenance, and crash scenarios can be prevented or mitigated by complying with safety regulations and voluntary standards and industry best practices. Tire testing showed tire rolling resistance did not impact of Class 8 tractor-trailer stopping distance for the tires tested. Also, because the majority of HD pickup and van fleet are above 4,594 lbs, the vehicle mass reduction in HD pickup and vans is estimated to reduce the net incidence of highway fatalities. Taken together, these studies suggest that the fuel efficiency improving technologies assessed in the studies can be implemented with no degradation in overall safety.

However, analysis anticipates that the indirect effect of the proposed standards, by reducing the operating costs, would lead to increased travel by tractor-trailers and HD pickups and vans and, therefore, more crashes involving these vehicles.

X. Analysis of the Alternatives

As discussed throughout this preamble, in developing this proposal the agencies considered a number of regulatory alternatives that could result in potentially fewer or greater GHG emission and fuel consumption reductions than the program we are proposing. This section summarizes the alternatives we considered and presents estimates of technology costs, CO_2 reductions, fuel savings, and other costs and benefits associated with each alternative. The agencies request comment on each of these alternatives, as well as other potential levels of stringency and implementation timing. Note that since the impacts of these alternatives differ among the various heavy-duty vehicle categories, commenters are encouraged to address the alternatives separately for each vehicle category.

In developing alternatives, both agencies must consider a range of stringency. NHTSA must consider EISA's requirement for the MD/HD fuel efficiency program. In particular, 49 U.S.C. 32902(k)(2) and (3) contain the following three requirements specific to the MD/HD vehicle fuel efficiency improvement program: (1) The program must be ''designed to achieve the maximum feasible improvement''; (2) the various required aspects of the program must be appropriate, cost-effective, and technologically feasible for MD/HD vehicles; and (3) the standards adopted under the program must provide not less than four model years of lead time and three model years of regulatory stability. In considering these various requirements, NHTSA will also account for relevant environmental and safety considerations.

As explained in the Phase 1 rule, NHTSA has broad discretion in balancing the above factors in determining the improvement that the manufacturers can achieve. The fact that the factors may often be conflicting gives NHTSA significant discretion to decide what weight to give each of the competing policies and concerns and then determine how to balance them—as long as NHTSA's balancing does not undermine the fundamental purpose of the EISA: Energy conservation, and as long as that balancing reasonably accommodates ''conflicting policies that were committed to the agency's care by the statute.'' [784]

EPA also has significant discretion in considering a range of stringency. Section 202(a)(2) of the Clean Air Act requires only that the standards ''take effect after such period as the Administrator finds necessary to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period.'' This language affords EPA considerable discretion in how to weight the critical statutory factors of emission reductions, cost, and lead time. See 76 FR 57129–57130.

[784] *Center for Biological Diversity* v. *National Highway Traffic Safety Admin.,* 538 F.3d 1172, 1194 (9th Cir. 2008). For further discussion see 76 FR 57198.

As discussed in this Preamble's Sections II (Engines), III (Tractors), IV (Trailers), V (Vocational Vehicles), And VI (Pickups And Vans), although NHTSA and EPA are proposing Alternative 3 for each vehicle category, we have also closely examined the potential feasibility of Alternative 4 for each category, and specifically direct commenters' attention to the analysis and discussions contained in those sections for both Alternatives 3 and 4. As discussed in those sections, if we reanalyze relevant existing information or receive relevant comments or new information between the proposal and final rule that supports a more accelerated implementation of the proposed standards, the agencies may consider establishing final fuel consumption and GHG standards at the Alternative 4 levels and timing if we deem them to be maximum feasible and reasonable for NHTSA and EPA, respectively. This Section X describes all of the alternatives considered, and provides context for the relative stringency, costs, and benefits associated with Alternatives 3 and 4, as compared to the other alternatives. The agencies seek comment on all of the alternatives, as well as whether we should consider more, fewer or different alternatives for the final rule analysis.

A. What are the alternatives that the Agencies considered?

The five alternatives below represent a broad range of potential stringency levels, and thus a broad range of associated technologies, costs and benefits for a HD vehicle fuel efficiency and GHG emissions program. All of the alternatives were modeled using the same methodologies described in Chapter 5 of the draft RIA. The alternatives in order of increasing fuel efficiency and GHG emissions reductions are as follows:

(1) Alternative 1: No Action (The Baseline for Phase 2)

OMB guidance regarding regulatory analysis indicates that proper evaluation of the benefits and costs of regulations and their alternatives requires agencies to identify a baseline:

''You need to measure the benefits and costs of a rule against a baseline. This baseline should be the best assessment of the way the world would look absent the proposed action. The choice of an appropriate baseline may require consideration of a wide range of potential factors, including:

- *Evolution of the market,*
- *changes in external factors affecting expected benefits and costs,*

• *changes in regulations promulgated by the agency or other government entities, and*

• *the degree of compliance by regulated entities with other regulations. It may be reasonable to forecast that the world absent the regulation will resemble the present. If this is the case, however, your baseline should reflect the future effect of current government programs and policies. For review of an existing regulation, a baseline assuming no change in the regulatory program generally provides an appropriate basis for evaluating regulatory alternatives. When more than one baseline is reasonable and the choice of baseline will significantly affect estimated benefits and costs, you should consider measuring benefits and costs against alternative baselines. In doing so you can analyze the effects on benefits and costs of making different assumptions about other agencies' regulations, or the degree of compliance with your own existing rules. In all cases, you must evaluate benefits and costs against the same baseline. You should also discuss the reasonableness of the baselines used in the sensitivity analyses. For each baseline you use, you should identify the key uncertainties in your forecast.''* [785]

A no-action alternative is also required as a baseline against which to measure environmental impacts of the proposed standards and alternatives. NHTSA, as required by the National Environmental Policy Act, is documenting these estimated impacts in the draft EIS published with this proposed rule.[786]

As discussed later in this section, the agencies are requesting comment on Alternative 1 in order to ensure an appropriate analytical baseline (also termed 'reference case') for the Phase 2 rulemaking. Alternative 1 is an analytical tool, but, as discussed below, no new standards beyond Phase 1 is not a potential outcome of the Phase 2 rulemaking, as that outcome would not meet the requirements of either EISA or the CAA.

The No Action Alternative for today's analysis, alternatively referred to as the ''baseline'' or ''reference case,'' assumes that the agencies would not issue new rules regarding MD/HD fuel efficiency and GHG emissions. That is, this alternative assumes that the Phase 1 MD/HD fuel efficiency and GHG emissions program's model year 2018 standards would be extended indefinitely and without change.

The agencies recognize that there are a number of factors that create uncertainty in projecting a baseline against which to compare the future effects of the proposed action and the remaining alternatives. The composition of the future fleet—such as the relative position of individual manufacturers and the mix of products they each offer—cannot be predicted with certainty at this time. As reflected, in part, by the market forecast underlying the agencies' analysis, we anticipate that the baseline market for medium- and heavy-duty vehicles will continue to evolve within a competitive market that responds to a range of factors. Additionally, the heavy-duty vehicle market is diverse, as is the range of vehicle purchasers.

Heavy-duty vehicle manufacturers have reported that their customers' purchasing decisions are influenced by their customers' own determinations of minimum total cost of ownership, which can be unique to a particular customer's circumstances. For example, some customers (*e.g.,* less-than-truckload or package delivery operators) operate their vehicles within a limited geographic region and typically own their own vehicle maintenance and repair centers within that region. These operators tend to own their vehicles for long time periods, and sometimes for the entire service life of the vehicle. Their total cost of ownership is influenced by their ability to better control their own maintenance costs, and thus they can afford to consider fuel efficiency technologies that have longer payback periods, outside of the vehicle manufacturer's warranty period. Other customers (*e.g.* truckload or long-haul operators) tend to operate cross-country, and thus must depend upon truck dealer service centers for repair and maintenance. Some of these customers tend to own their vehicles for about four to seven years, so that they typically do not have to pay for repair and maintenance costs outside of either the manufacturer's warranty period or some other extended warranty period. Many of these customers tend to require seeing evidence of fuel efficiency technology payback periods on the order of 18 to 24 months before seriously *considering* evaluating a new technology for potential adoption within their fleet (NAS 2010, Roeth et al. 2013, Klemick et al. 2014). Purchasing decisions, however, are not based exclusively on payback period, but also include the considerations discussed in this section. For the baseline analysis, the agencies use payback period as a proxy for all of these considerations, and therefore the payback period for the baseline analysis is shorter than the payback period industry uses as a threshold for the further consideration of a technology.

Purchasers of HD pickups and vans wanting better fuel efficiency will demand that fuel consumption improvements pay back within approximately one to three years, but not all purchasers fall into this category. Some HD pickup and van owners accrue relatively few vehicle miles traveled per year, such that they may be less likely to adopt new fuel efficiency technologies, while other owners who use their vehicle(s) with greater intensity may be even more willing to pay for fuel efficiency improvements. Regardless of the type of customer, their determination of minimum total cost of ownership involves the customer balancing their own unique circumstances with a heavy-duty vehicle's initial purchase price, availability of credit and lease options, expectations of vehicle reliability, resale value and fuel efficiency technology payback periods. The degree of the incentive to adopt additional fuel efficiency technologies also depends on customer expectations of future fuel prices, which directly impacts customer expectations of the payback period.

Another factor the agencies considered is that other federal and state-level policies and programs are specifically aimed at stimulating fuel efficiency technology development and deployment. Particularly relevant to this sector are DOE's 21st Century Truck Partnership, EPA's voluntary SmartWay Transport program, and California's AB32 fleet requirements.[787] [788] [789] The future availability of more cost-effective technologies to reduce fuel consumption could provide manufacturers an incentive to produce

[785] OMB Circular A–4, September 17, 2003. Available at *http://www.whitehouse.gov/omb/circulars_a004_a-4.*

[786] NEPA requires agencies to consider a ''no action'' alternative in their NEPA analyses and to compare the effects of not taking action with the effects of the reasonable action alternatives to demonstrate the different environmental effects of the action alternatives. *See* 40 CFR 1502.2(e), and 1502.14(d). CEQ has explained that ''[T]he regulations require the analysis of the no action alternative even if the agency is under a court order or legislative command to act. This analysis provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of the action alternatives. [*See* 40 CFR 1502.14(c).] * * * Inclusion of such an analysis in the EIS is necessary to inform Congress, the public, and the President as intended by NEPA. [*See* 40 CFR 1500.1(a).]'' Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 FR 18026 (1981) (emphasis added).

[787] *http://energy.gov/eere/vehicles/vehicle-technologies-office-21st-century-truck.*

[788] *http://www.epa.gov/smartway/.*

[789] State of California Global Warming Solutions Act of 2006 (Assembly Bill 32, or AB32).

more fuel-efficient medium- and heavy-duty vehicles, which in turn could provide customers an incentive to purchase these vehicles. The availability of more cost-effective technologies to reduce fuel consumption could also lead to a substitution of less cost-effective technologies, where overall fuel efficiency could remain fairly flat if buyers are less interested in fuel consumption improvements than in reduced vehicle purchase prices and/or improved vehicle performance and/or utility.

Although we have estimated the cost and efficacy of fuel-saving technologies assuming performance and utility will be held constant, some uncertainty remains regarding whether these conditions will actually be observed. In particular, we have assumed payload will be preserved (and possibly improved via reduced vehicle curb weight); however, some fuel-saving technologies, such as natural gas fueled vehicles and hybrid electric vehicles, could reduce payload via increased curb weight due to the fuel tanks or added electrical machine, batteries and controls. It is also possible that under extended high power demand resulting from a vehicle towing up a road grade, certain types of hybrid powertrains could experience a temporary loss of towing capacity if the capacity of the hybrid's energy storage device (*e.g.,* batteries, hydraulic accumulator) is insufficient for the extended power demand. We have also assumed that fuel-saving technologies will be no more or less reliable than technologies already in production. However, if manufacturers pursue risky technologies or if the agencies provide insufficient lead-time to fully develop new technologies, they could prove to be less reliable, perhaps leading to increased repair costs and out-of-service time. This was observed as an unintended consequence of certain manufacturers' initial introduction of certain emissions control technologies to meet EPA's most stringent heavy-duty engine standards. If the fuel-saving technologies considered here ultimately involve similar reliability problems, overall costs will be greater than we have estimated. We have assumed drivers will be as accepting of new fuel-saving technologies as they are of technologies already in service. However, drivers could be less accepting of newer technologies—particularly any which must be deployed manually. Except for increased costs to replace more efficient tires, we have assumed that routine maintenance costs will not increase or decrease. However, maintenance of new technologies could involve unique tools and parts. Therefore, maintenance costs could increase, and maintenance could involve increased vehicle out-of-service time. On the other hand new technologies can sometimes prove to be more reliable and require less maintenance than the technologies they replace. One example of this is the auxiliary power unit (APU) frequently installed on heavy-duty sleeper cab tractors. In the past these have been typically powered by small nonroad diesel engines that can require more frequent maintenance than the main engine of the tractor itself. However, more recently, as electric battery technology has advanced, some tractor manufacturers have introduced battery APUs instead of engine-driven APUs. A comparison of recent sales of small engine driven APUs versus battery APUs suggests that customers may prefer battery APUs,[790] and some operators and tractor dealerships have also told the agencies that the decrease in routine maintenance was an important factor in purchase decisions in favor of battery APUs. Again, insofar as these unaccounted-for costs or savings actually occur, overall costs could be larger or smaller than we have estimated. We have also applied the EIA's AEO estimates of future fuel prices; however, heavy-duty vehicle customers could have different expectations about future fuel prices, and could therefore be more inclined or less inclined to apply new technology to reduce fuel consumption than might be expected based on EIA's forecast. We expect that vehicle customers will be uncertain about future fuel prices, and that this uncertainty will be reflected in the degree of enthusiasm to apply new technology to reduce fuel consumption.

Considering all of these factors, the agencies have approached the definition of the No Action Alternative separately for each vehicle and engine category covered by today's proposal.

For trailers, the agencies considered two No Action alternatives to cover a nominal range of uncertainty. The trailer category is unique in the context of this rulemaking because it is the only heavy-duty category not regulated under Phase 1. In both No Action cases, the agencies projected that the combination of EPA's voluntary SmartWay program, DOE's 21st Century Truck Partnership, California's AB32 trailer requirements for fleets, and the potential for significantly reduced operating costs should result in continuing improvement to new trailers. Taking this into account, the agencies project that in 2018, 50 percent of new 53′ dry van and reefer trailers would have technologies qualifying for the SmartWay label (5 percent aerodynamic improvements and lower rolling resistance tires) and 50 percent would have automatic tire inflation systems to maintain optimal tire pressure. We also project that adoption of those same technologies would increase 1 percent per year until each technology is being used on 60 percent of new trailers. In the first case, Alternative 1a, this means that the agencies project that in the absence of new standards, the new trailer fleet technology would stabilize in 2027 to a level of 60 percent adoption in 2027 for the No Action alternative. In the second case, Alternative 1b, the agencies projected that the fraction of the in-use fleet qualifying for SmartWay would continue to increase beyond 2027 as older trailers are replaced by newer trailers. We projected that these improvements would continue until 2040 when 75 percent of new trailers would be assumed to include skirts.

For vocational vehicles, the agencies considered one No Action alternative. For the vocational vehicle category the agencies recognized that these vehicles tend to operate over fewer vehicle miles travelled per year. Therefore, the projected payback periods for fuel efficiency technologies available for vocational vehicles are generally longer than the payback periods the agencies consider likely to lead to their adoption based solely on market forces. This is especially true for vehicles used in applications in which the vehicle operation is secondary to the primary business of the company using the vehicle. For example, since the fuel consumption of vehicles used by utility companies to repair power lines would generally be a smaller cost relative to the other costs of repairing lines, fuel saving technologies would generally not be as strongly demanded for such vehicles. Thus, the agencies project that fuel-saving technologies would either not be applied or only be applied as a substitute for more expensive fuel efficiency technologies, except as necessitated by the Phase 1 fuel consumption and GHG standards.

For tractors, the agencies considered two No Action alternatives to cover a nominal range of uncertainty. For Alternative 1a the agencies project that fuel-saving technologies would either not be applied or only be applied as a substitute for more expensive fuel efficiency technologies to tractors (thereby enabling manufacturers to offer tractors that are less expensive to

[790] Confidence Report: Idle-Reduction Solutions, North American Council for Freight Efficiency, Lee, Tessa, 2014, p. 13.

purchase), except as necessitated by the Phase 1 fuel consumption and GHG standards. In Alternative 1b the agencies estimated that some available technologies would save enough fuel to pay back fairly quickly—within the first six months of ownership. The agencies considered a range of information to formulate these two baselines for tractors.

Both public [791] and confidential historical information shows that tractor trailer fuel efficiency improved steadily through improvements in engine efficiency and vehicle aerodynamics over the past 40 years, except for engine efficiency which decreased or was flat between 2000 and approximately 2007 as a consequence of incorporating technologies to meet engine emission regulations. Today vehicle manufacturers, the Federal Government, academia and others continue to invest in research to develop fuel efficiency improving technologies for the future.

There is also evidence that manufacturers have, in the past, applied technologies to improve fuel efficiency absent a regulatory requirement to do so. Some manufacturers have even taken regulatory risk in order to increase fuel efficiency; in the 1990s, when fuel was comparatively inexpensive, some tractor manufacturers designed tractor engine controls to determine when the vehicle was not being emissions tested and, under such conditions, shift to more fuel-efficient operation even though doing so caused the vehicles to violate federal standards for NO_X emissions. Also, some manufacturers have recently expressed concern that the Phase 1 tractor standards do not credit them for fuel-saving technologies they had already implemented before the Phase 1 standards were adopted.

In public meetings and in meetings with the agencies, the trucking industry stated that fuel cost for tractors is the number one or number two expense for many operators, and therefore is a very important factor for their business. However, the pre-Phase 1 market suggests that, tractor manufacturers and operators could be slow to adopt some new technologies, even where the agencies have estimated that the technology would have paid for itself within a few months of operation. Tractor operators have told the agencies they generally require technologies to be demonstrated in their fleet before widespread adoption so they can assess the actual fuel savings for their fleet and any increase in cost associated with effects on vehicle operation, maintenance, reliability, mechanic training, maintenance and repair equipment, stocking unique parts and driver acceptance, as well as effects on vehicle resale value. Tractor operators have publicly stated they would consider conducting an assessment of technologies when provided with data that show the technologies may payback costs through fuel savings within 18 to 24 months, based on their assumptions about future fuel costs. In these cases, an operator may first conduct a detailed paper study of anticipated costs and benefits. If that study shows likely payback in 18 to 24 months for their business, the fleet may acquire one or several tractors with the technology to directly measure fuel savings, costs and driver acceptance for their fleet. Small fleets may not have resources to conduct assessments to this degree and may rely on information from larger fleets or observations of widespread acceptance of the technology within the industry before adopting a technology. This uncertainty over the actual fuel savings and costs and the lengthy process to assess technologies significantly slows the pace at which fuel efficiency technologies are adopted.

The agencies believe that using the two baselines addresses the uncertainties we have identified for tractors. The six-month payback period of Alternative 1b reflects the agencies' consideration of factors, discussed above, that could limit—yet not eliminate—manufacturers' tendencies to voluntarily improve fuel consumption. In contrast, Alternative 1a reflects a baseline for vehicles other than trailers wherein manufacturers either do not apply fuel efficiency technologies or only apply them as a substitute for more expensive fuel efficiency technologies, except as necessitated by the Phase 1 fuel consumption and GHG standards.

For HD pickups and vans, the agencies considered two No Action alternatives to cover a nominal range of uncertainty. In Alternative 1b the agencies considered additional technology application, which involved the explicit estimation of the potential to add specific fuel-saving technologies to each specific vehicle model included in the agencies' HD pickup and van fleet analysis, as discussed in Chapter VI. Estimated technology application and corresponding impacts depend on the modeled inputs. Also, under this approach a manufacturer that has improved fuel consumption and GHG emissions enough to achieve compliance with the standards is assumed to apply further improvements, provided those improvements reduce fuel outlays by enough (within a specified amount of time, the payback period) to offset the additional costs to purchase the new vehicle. These calculations explicitly account for and respond to fuel prices, vehicle survival and mileage accumulation, and the cost and efficacy of available fuel-saving technologies. Therefore, all else being equal, more technology is applied when fuel prices are higher and/or technology is more cost-effective. Manufacturers of HD pickups and vans have reported to the agencies that buyers of these vehicles consider the total cost of vehicle ownership, not just new vehicle price, and that manufacturers plan as if buyers will expect fuel consumption improvements to "pay back" within periods ranging from approximately one to three years. For example, some manufacturers made decisions to introduce more efficient HD vans and HD pickup transmissions before such vehicles were subject to fuel consumption and/or GHG standards. However, considering factors discussed above that could limit manufacturers' tendency to voluntarily improve HD pickup and van fuel consumption, Alternative 1b applies a 6-month payback period. In contrast for Alternative 1a the agencies project that fuel-saving technologies would either not be applied or only be applied as a substitute for more expensive fuel efficiency technologies, except as necessitated by the Phase 1 fuel consumption and GHG standards. The Method A sensitivity analysis presented above in Section VI also examines other payback periods. In terms of impacts under reference case fuel prices, the payback period input plays a more significant role under the No-Action Alternatives (defined by a continuation of model year 2018 standards) than under the more stringent regulatory alternatives described next.

(2) Alternative 2: Less Stringent Than the Preferred Alternative

For vocational vehicles and combination tractor-trailers, Alternative 2 represents a stringency level which is approximately half as stringent overall as the preferred alternative. The agencies developed Alternative 2 to consider a continuation of the Phase 1 approach of applying off-the-shelf technologies rather than requiring the development of new technologies or

[791] Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles; National Research Council; Transportation Research Board (2010). "Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles," (hereafter, "NAS 2010"). Washington, DC. The National Academies Press. Available electronically from the National Academies Press Web site at *http://www.nap.edu/catalog.php?record_id=12845* (last accessed September 10, 2010).

fundamental improvements to existing technologies. For tractors and vocational vehicles, this also involved less integrated optimization of the vehicles and engines. Put another way, Alternative 2 is not technology-forcing. See, *e.g., Sierra Club* v. *EPA,* 325 F. 3d 374, 378 (D.C. Cir. 2003) (under a technology-forcing provision, EPA ''must consider future advances in pollution control capability''); see also similar discussion in *Husqvarna AB* v. *EPA,* 254 F. 3d 195, 201 (D.C. Cir. 2001).

The agencies' decisions regarding which technologies could be applied to comply with Alternative 2 considered not only the use of off-the shelf technologies, but also considered other factors as well, such as how broadly certain technologies fit in-use applications and regulatory structure. The resulting Alternative 2 could be met with most of the same technologies the agencies project could be used to meet the proposed standards, although at lower application rates. Alternative 2 is estimated to be achievable without the application of some technologies, at any level. These and other differences are described below by category.

The agencies project that Alternative 2 combination tractor standards could be met by applying lower adoption rates of the projected technologies for Alternative 3. This includes a projection of slightly lower per-technology effectiveness for Alternative 2 versus 3. Alternative 2 also assumes that there would be little optimization of combination tractor powertrains.

The agencies project that the Alternative 2 vocational vehicle standard could be met without any use of strong hybrids. Rather, it could be met with lower adoption rates of the other technologies that could be used to meet Alternative 3, our proposed standards. This includes a projection of slightly lower per-technology effectiveness for Alternative 2 versus 3 and little optimization of vocational vehicle powertrains.

The Alternative 2 trailer standards would apply to only 53-foot dry and refrigerated box trailers and could be met through the use of less effective aerodynamic technologies and higher rolling resistance tires versus what the agencies projected could be used to meet Alternative 3.

As discussed above in Section VI.D., the HD pickup truck and van alternatives are characterized by an annual required percentage change (decrease) in the functions defining attribute-based targets for per-mile fuel consumption and GHG emissions. Under the standards in each alternative, a manufacturer's fleet would, setting aside any changes in production mix, be required to achieve average fuel consumption/GHG levels that increase in stringency every year relative to the standard defined for MY2018 (and held constant through 2020) that establishes fuel consumption/GHG targets for individual vehicles. A manufacturer's specific fuel consumption/GHG requirement is the sales-weighted average of the targets defined by the work-factor curve in each year. Therefore, although the alternatives involve steady increases in the functions defining the targets, stringency increases faced by any individual manufacturer may not be steady if changes in the manufacturer's product mix cause fluctuations in the average fuel consumption and GHG levels required of the manufacturer. See Section VI.D. for additional discussion of this topic. Alternative 2 represents a 2.0 percent annual improvement through 2025 in fuel consumption/GHG emissions relative to the work-factor curve in 2020. This would be 0.5 percent less stringent per year compared to the proposed standards of Alternative 3.

For HD pickups and vans the agencies project that most manufacturers could comply with the standards defining Alternative 2 by applying technologies similar to those that could be applied in order to comply with the proposed standards, but at lower application rates than could be necessitated by the proposed standards. The biggest technology difference the agencies project between Alternative 2 and the proposed standards of Alternative 3 would be that we project that most manufacturers could meet the Alternative 2 standards without any use of stop-start or other mild or strong hybrid technologies.

Of course, these estimates depend not only on the stringency of the standards defining this regulatory alternative, but also on other input estimates, in particular the detailed composition of the agencies' HD pickup and van market forecast; the agencies' estimates of the future availability, cost, and efficacy of fuel-saving HD pickup and van technologies; and the agencies' estimates of future fuel prices. Even without changes to the standards defining this regulatory alternative, changes to analysis inputs would lead to different estimates of the extent to which various technologies might be applied under this regulatory alternative.

The agencies are not proposing Alternative 2 as a matter of both policy and law. Based on our current analysis for each of the subcategories, it presently appears that technically feasible alternate standards are available that provide for greater emission reductions and reduced fuel consumption, including the proposed standards. Such alternative standards, including the proposed standards and potentially Alternative 4, are feasible at reasonable cost, considering both per-vehicle and per-engine cost, cost-effectiveness, and lead time. Consequently, at this point the agencies do not believe that the modest improvements in Alternative 2 would be appropriate or otherwise reasonable under Section 202(a)(1) and (2) of the Clean Air Act, or represent the ''maximum feasible improvement'' within the meaning of 49 U.S.C. 32902(k)(2).

(3) Alternative 3: Preferred Alternative and Proposed Standards

The agencies are proposing Alternative 3 for HD engines, HD pickup trucks and vans, Class 2b through Class 8 vocational vehicles, Class 7 and 8 combination tractors, and most categories of trailers. Details regarding modeling of this alternative are included in Chapter 5 of the draft RIA.

Unlike the Phase 1 standards where the agencies projected that manufacturers could meet the Phase 1 standards with off-the-shelf technologies only, the agencies project that Alternative 3 standards could be met through a combination of off-the-shelf technologies applied at higher market penetration rates and new technologies that are still in various stages of development and not yet in production. Although this alternative is technology-forcing, it must be kept in mind that the standards themselves are performance-based and thus do not mandate any particular technology be used to meet the standards. The agencies recognize that there is some uncertainty in projecting costs and effectiveness for those technologies not yet available on the market, but we do not believe, as discussed comprehensively in Sections II, III, IV, V, and VI, that such uncertainty is not sufficient to render Alternative 3 beyond the reasonable or maximum feasible level of stringency for each of the vehicle categories covered by this program. Given that all of the proposed standards are performance-based rather than mandates of specific technologies, and given that the lead time for the most stringent standards in Alternative 3 is greater than 10 years, the agencies believe that the performance that would be required by these stringency levels of Alternative 3 would allow each manufacturer to choose to develop technology and apply it to their vehicles in a way that balances their unique business constraints and reflects their specific market position and customers' needs.

We have described in detail above, and also in Chapter 2 of the draft RIA, the precise bases for each of the proposed standards (that is, for each segment covered under the program). For HD pickups and vans, Alternative 3 represents a 2.5 percent compounded annual improvement through 2027 in fuel consumption/GHG emissions relative to the work-factor curve in 2020.

Sections II through VI of this notice provide comprehensive explanations of the consideration that the agencies gave to proposing standards that are more accelerated than Alternative 3, based on the agencies' projection of how such standards could be met through the accelerated application of technologies and our reasons for concluding that the identified technologies for each of the vehicle and engine standards that constitute Alternative 3 represent the maximum feasible (within the meaning of 49 U.S.C. 32902(k)) and reasonable (for purposes of CAA section 202 (a)) based on all of the information available to the agencies at the time of this proposal.

(4) Alternative 4: More Accelerated Than the Preferred Alternative

As indicated by its description in the title above, Alternative 4 represents standards that are effective on a more accelerated timeline in comparison to the timeline of the proposed standards in Alternative 3. The agencies believe that Alternative 4 could potentially be maximum feasible and appropriate, but at this time the agencies have identified sufficient uncertainty in the information that the agencies have considered with respect to the technologies' readiness, effectiveness and costs such that the agencies cannot yet conclude that Alternative 4 represents maximum feasible and appropriate standards. Accordingly, although we are not proposing Alternative 4, we are requesting comment on adopting some or all of Alternative 4 in the final rule. The agencies would especially welcome data on the projected readiness, effectiveness, and costs of technologies the agencies consider for compliance with Alternative 4 standards, which in many cases are identical to the technologies considered for the Alternative 3 standards. It would be especially helpful if commenters addressed each category separately; namely, tractors and vocational vehicles and their engines; trailers, and pickups and vans. The agencies would consider adopting Alternative 4's stringencies and lead time for the final rule, depending on the information and comments received in response to this notice and based on additional consideration of the information we already have in-hand.

Alternatives 3 and 4 were both designed to achieve similar fuel efficiency and GHG emission levels in the long term but with Alternative 4 being accelerated in its implementation timeline. Specifically, alternative 4 reflects the same or similar standard stringency levels as alternative 3, but 3 years sooner (2 years for heavy-duty pickups and vans), so that the final phase of the standards would occur in MY 2024, or (for heavy duty pickups and vans) 2025.

As discussed above and in the feasibility discussions in Sections II–VI, we are not proposing Alternative 4. By accelerating the adoption schedule, this option would result in several model years of incrementally greater fuel consumption and GHG emission reductions than Alternative 3, but it does raise concerns about adequacy of lead time. The agencies have outstanding questions regarding relative risks and benefits of Alternative 4 due to the timeframe envisioned by that alternative.

The agencies recognize the potential for larger net benefits if Alternative 4 were selected, and we therefore welcome comments addressing the feasibility and availability of relevant technologies in the identified lead time. Commenters are particularly encouraged to address all aspects of feasibility analysis, including effectiveness and costs, the likelihood of developing available technologies to achieve sufficient reliability within the proposed lead time, and the extent to which the heavy-duty vehicle market would accept and utilize the technology. Comments should ideally address these issues separately for each type of technology, especially with respect to advanced technologies like waste heat recovery systems and hybrid powertrains. Although we summarize the specific differences below, readers are encouraged to see Sections II through VI for more detailed descriptions of how the agencies projected how manufacturers could implement certain technologies in order to meet the standards of Alternative 4.

The agencies project that Alternative 4 combination tractor standards could be met by applying initially higher adoption rates of the projected technologies for Alternative 3. This includes a projection of slightly higher per-technology effectiveness for Alternative 4 versus 3. Alternative 4 also assumes that there would be more optimization of combination tractor powertrains and earlier market penetration of engine waste heat recovery systems.

The agencies project that the Alternative 4 vocational vehicle standard could be met through earlier adoption rates of the same technology packages projected for Alternative 3. This includes a projection of slightly higher per-technology effectiveness for Alternative 4 versus 3.

The Alternative 4 trailer standards could be met through earlier implementation of more effective aerodynamic technologies, including the use of aerodynamic skirts and boat tails. This would be in addition to implementing lower rolling resistance tires for nearly all trailers.

HD pickup truck and van standards defining Alternative 4 represent a 3.5 percent annual improvement in fuel consumption and GHG emissions through 2025 relative to the work-factor curves in 2020. Of course, this finding depends not only on the stringency of the standards defining this regulatory alternative, but also on other input estimates, in particular the detailed composition of the agencies' HD pickup and van market forecast; the agencies' estimates of the future availability, cost, and efficacy of fuel-saving HD pickup and van technologies; and the agencies' estimates of future fuel prices. Even without changes to the standards defining this regulatory alternative, changes to analysis inputs will lead to different estimates of the extent to which various technologies might be applied under this regulatory alternative.

(5) Alternative 5: Even More Stringent Standards With No Additional Lead-Time

Alternative 5 represents even more stringent standards compared to Alternatives 3 and 4, as well as the same implementation timeline as Alternative 4. As discussed above and in the feasibility discussions in Sections II–VI, we are not proposing Alternative 5 because we cannot project that manufacturers can develop and introduce in sufficient quantities the technologies that could be used to meet Alternative 5 standards. We believe that for some or all of the categories, the Alternative 5 standards are technically infeasible within the lead time allowed. We have not fully estimated costs for this alternative for tractors and vocational vehicles because we believe that there would be such substantial additional costs related to pulling ahead the development of so many additional technologies that we cannot accurately predict these costs. We also believe this alternative could result in a decrease in the in-use reliability and durability of new heavy-duty vehicles and that we do not have the ability to accurately quantify the costs that would be associated with such problems. Instead we merely note that costs would be significantly greater than the estimated costs for Alternatives 3 and 4.

B. How do these alternatives compare in overall fuel consumption and GHG emissions reductions and in benefits and costs?

The following tables compare the overall fuel consumption and GHG emissions reductions and benefits and costs of each of the regulatory alternatives the agencies considered.

Note that for tractors, trailers, pickups and vans the agencies compared overall fuel consumption and GHG emissions reductions and benefits and costs relative to two different baselines, described above in the section on the No Action alternative. Therefore, for tractors, trailers, pickups and vans two results are listed; one relative to each baseline, namely Alternative 1a and Alternative 1b.

Also note that the agencies analyzed pickup and van overall fuel consumption and emissions reductions and benefits and costs using the NHTSA's CAFE model (Method A). In addition, the agencies used EPA's MOVES model to estimate pickup and van fuel consumption and emissions and a cost methodology that applied vehicle costs in different model years (Method B). In both cases, the agencies used the CAFE model to estimate average per vehicle cost, and this analysis extended through model year 2030.[792] The agencies concluded that in these instances the choice of baseline and the choice of modeling approach (Method A versus Method B) did not impact the agencies' decision to propose Alternative 3 as the preferred alternative and hence the proposed standards for HD pickups and vans.

Table X–1 compares fuel savings, technology costs, avoided emissions, total costs, and benefits for the above regulatory alternatives as estimated under Method A. Table X–2 provides the same comparisons for Method B. Subsequent tables summarize segment-specific results and projections for longer-term impacts. The regulatory impact analysis (RIA) accompanying today's notice presents more detailed results of the agencies' analysis.

(1) Method A Tables

TABLE X–1—SUMMARY OF COSTS AND BENEFITS THROUGH MY 2029 BY ALTERNATIVE, DISCOUNTED AT 3% (RELATIVE TO BASELINE 1a), METHOD A [a]

Vehicle segment	Alt 2	Alt 3	Alt 4	Alt 5
Discounted pre-tax fuel savings ($billion)				
HD pickups and Vans	11.7	18.3	22.3	24.8
Vocational Vehicles	5.6	18.4	24.3	38.5
Tractors/Trailers	88.1	138.4	151.7	196.8
Total	105.4	175.1	198.3	260.2
Discounted Total technology costs ($billion)				
HD pickups and Vans	3.0	5.0	8.2	9.9
Vocational Vehicles	1.2	7.6	10.8	26.0
Tractors/Trailers	9.2	12.8	15.3	34.8
Total	13.4	25.4	34.3	70.6
Discounted value of emissions reductions ($billon)				
HD pickups and Vans	3.0	4.8	5.9	6.6
Vocational Vehicles	1.7	6.1	8.1	13.1
Tractors/Trailers	40.7	62.7	67.9	87.7
Total	45.4	73.7	82.0	107.4
Total costs ($billion)				
HD pickups and Vans	3.5	5.7	9.1	15.2
Vocational Vehicles	3.0	9.5	12.8	28.1
Tractors/Trailers	11.5	15.5	18.1	37.5
Total	18.0	30.8	40.0	80.8
Total benefits ($billion)				
HD pickups and Vans	17.2	27.0	33.0	36.7
Vocational Vehicles	12.7	31.2	39.7	60.2
Tractors/Trailers	142.5	217.5	236.7	304.2
Total	172.4	275.8	309.4	401.1

[792] Although the agencies have considered regulatory alternatives involving standards increasing in stringency through, at the latest, 2027, the agencies extended the CAFE modeling analysis through model year 2030 rather than model year 2027 in order to obtain more fully stabilized results given projected product cadence, multiyear planning, and application of earned credits.

TABLE X–1—SUMMARY OF COSTS AND BENEFITS THROUGH MY 2029 BY ALTERNATIVE, DISCOUNTED AT 3% (RELATIVE TO BASELINE 1a), METHOD A[a]—Continued

Vehicle segment	Alt 2	Alt 3	Alt 4	Alt 5
Net benefits ($billion)				
HD pickups and Vans	13.7	21.3	23.9	21.5
Vocational Vehicles	9.6	21.7	26.9	32.1
Tractors/Trailers	131.0	202.0	218.7	266.7
Total	154.3	245.0	269.4	320.3

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE X–2—SUMMARY OF PROGRAM BENEFITS AND COSTS THROUGH MY 2029, DISCOUNTED AT 3% (RELATIVE TO BASELINE 1B), METHOD A[a]

Vehicle segment	Alt 2	Alt 3	Alt 4	Alt 5
Discounted pre-tax fuel savings ($billion)				
HD pickups and Vans	9.6	15.9	19.1	22.2
Vocational Vehicles	5.6	18.4	24.3	38.5
Tractors/Trailers	80.5	130.8	144.0	189.2
Total	95.6	165.1	187.4	250.0
Discounted Total technology costs ($billion)				
HD pickups and Vans	2.5	5.0	7.2	9.7
Vocational Vehicles	1.2	7.6	10.8	25.9
Tractors/Trailers	8.9	12.5	15.0	34.4
Total	12.5	25.0	32.9	70.0
Discounted value of emissions reductions ($billon)				
HD pickups and Vans	2.8	4.5	5.4	6.3
Vocational Vehicles	1.7	6.1	8.1	13.1
Tractors/Trailers	37.5	59.4	64.6	84.4
Total	41.9	70.1	78.2	103.8
Total costs ($billion)				
HD pickups and Vans	2.8	5.5	7.8	10.4
Vocational Vehicles	3.0	9.5	12.8	28.0
Tractors/Trailers	11.2	15.2	17.7	37.2
Total	17.0	30.3	38.4	75.7
Total benefits ($billion)				
HD pickups and Vans	14.1	23.5	28.3	32.9
Vocational Vehicles	12.7	31.2	39.7	60.2
Tractors/Trailers	131.1	206.2	225.4	292.8
Total	157.9	260.9	293.3	385.9
Net benefits ($billion)				
HD pickups and Vans	11.3	18.0	20.4	22.5
Vocational Vehicles	9.6	21.7	26.9	32.1
Tractors/Trailers	119.9	191.0	207.6	255.6
Total	140.9	230.7	254.9	310.3

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

The following two tables summarize results for each of the segments covered by today's proposal, discounted at 7 percent.

TABLE X–3—SUMMARY OF PROGRAM BENEFITS AND COSTS THROUGH MY 2029, DISCOUNTED AT 7% (RELATIVE TO BASELINE 1a), METHOD A[a]

Vehicle segment	Alt 2	Alt 3	Alt 4	Alt 5
Discounted pre-tax fuel savings ($billion)				
HD pickups and Vans	6.4	9.9	12.2	13.6
Vocational Vehicles	2.9	9.7	13.0	20.9
Tractors/Trailers	47.7	74.6	82.3	107.3
Total	57.0	94.2	107.5	141.8
Discounted Total technology costs ($billion)				
HD pickups and Vans	2.1	3.4	5.7	6.9
Vocational Vehicles	0.8	5.0	7.3	17.8
Tractors/Trailers	6.3	8.7	10.5	23.9
Total	9.1	17.1	23.5	48.6
Discounted value of emissions reductions ($billon)				
HD pickups and Vans	2.7	4.3	5.3	5.9
Vocational Vehicles	1.4	5.0	6.6	10.6
Tractors/Trailers	29.9	46.3	50.4	65.4
Total	34.0	55.6	62.3	81.8
Total costs ($billion)				
HD pickups and Vans	2.4	3.8	6.2	10.1
Vocational Vehicles	1.8	6.1	8.4	19.0
Tractors/Trailers	7.6	10.3	12.1	25.5
Total	11.8	20.2	26.7	54.6
Total benefits ($billion)				
HD pickups and Vans	10.4	16.3	20.1	22.3
Vocational Vehicles	7.3	18.3	23.6	36.2
Tractors/Trailers	85.1	130.0	142.2	183.5
Total	102.9	164.6	185.8	242.1
Net benefits ($billion)				
HD pickups and Vans	8.1	12.4	13.9	12.2
Vocational Vehicles	5.5	12.2	15.2	17.2
Tractors/Trailers	77.5	119.7	130.1	158.0
Total	91.1	144.4	159.1	187.5

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE X–4—SUMMARY OF PROGRAM BENEFITS AND COSTS THROUGH MY 2029, DISCOUNTED AT 7% (RELATIVE TO BASELINE 1b), METHOD A[a]

Vehicle segment	Alt 2	Alt 3	Alt 4	Alt 5
Discounted pre-tax fuel savings ($billion)				
HD pickups and Vans	5.2	8.5	10.4	12.2
Vocational Vehicles	2.9	9.7	13.0	20.9
Tractors/Trailers	44.0	71.0	78.6	103.7
Total	52.2	89.2	102.0	136.8
Discounted Total technology costs ($billion)				
HD pickups and Vans	1.7	3.4	4.9	6.7
Vocational Vehicles	0.8	5.0	7.3	17.8
Tractors/Trailers	6.0	8.4	10.3	23.7

TABLE X–4—SUMMARY OF PROGRAM BENEFITS AND COSTS THROUGH MY 2029, DISCOUNTED AT 7% (RELATIVE TO BASELINE 1b), METHOD A [a]—Continued

Vehicle segment	Alt 2	Alt 3	Alt 4	Alt 5
Total	8.5	16.8	22.5	48.2
Discounted value of emissions reductions ($billon)				
HD pickups and Vans	2.5	4.0	4.8	5.5
Vocational Vehicles	1.4	5.0	6.6	10.6
Tractors/Trailers	27.5	43.9	48.0	63.0
Total	31.4	52.9	59.4	79.1
Total costs ($billion)				
HD pickups and Vans	1.9	3.7	5.3	7.1
Vocational Vehicles	1.8	6.1	8.4	19.0
Tractors/Trailers	7.3	10.0	11.9	25.3
Total	11.1	19.8	25.6	51.4
Total benefits ($billion)				
HD pickups and Vans	8.6	14.1	17.1	20.0
Vocational Vehicles	7.3	18.3	23.6	36.2
Tractors/Trailers	78.9	123.7	135.9	177.3
Total	94.8	156.2	176.6	233.5
Net benefits ($billion)				
HD pickups and Vans	6.7	10.5	11.9	12.9
Vocational Vehicles	5.5	12.2	15.2	17.2
Tractors/Trailers	71.5	113.7	124.0	152.0
Total	83.7	136.4	151.1	182.2

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

While the agencies' explicit analysis of manufacturers' potential responses to today's proposed standards extends through model year 2030, the resulting fuel savings and avoided emissions summarized in the following two tables occur as those vehicles.

TABLE X–5—FUEL SAVINGS AND GHG EMISSIONS REDUCTIONS BY VEHICLE SEGMENT, RELATIVE TO BASELINE 1a, METHOD A [a]

MY 2018–2029 Total	Fuel reductions (billion gallons)	Upstream & downstream GHG reductions (MMT)
Alternative 2		
HD Pickup Trucks/Vans	5.5	67.5
Vocational Vehicles	2.5	33.6
Tractors and Trailers	37.8	518.8
Total	45.8	619.9
Alt. 3—Preferred Alternative		
HD Pickup Trucks/Vans	8.8	107.6
Vocational Vehicles	8.3	110.3
Tractors and Trailers	59.5	816.4
Total	76.7	1,034.3
Alt. 4		
HD Pickup Trucks/Vans	10.7	130.5
Vocational Vehicles	10.9	143.8

TABLE X–5—FUEL SAVINGS AND GHG EMISSIONS REDUCTIONS BY VEHICLE SEGMENT, RELATIVE TO BASELINE 1a, METHOD A [a]—Continued

MY 2018–2029 Total	Fuel reductions (billion gallons)	Upstream & downstream GHG reductions (MMT)
Tractors and Trailers	65.0	892.1
Total	86.7	1,166.4
Alt. 5		
HD Pickup Trucks/Vans	12.0	145.4
Vocational Vehicles	17.3	226.9
Tractors and Trailers	84.2	1,155.1
Total	113.4	1,527.4

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE X–6—FUEL SAVINGS AND GHG EMISSIONS REDUCTIONS BY VEHICLE SEGMENT, RELATIVE TO BASELINE 1b, METHOD A [a]

MY 2018–2029 Total	Fuel reductions (billion gallons)	Upstream & downstream GHG reductions (MMT)
Alternative 2		
HD Pickup Trucks/Vans	4.5	55.5
Vocational Vehicles	2.5	33.6
Tractors and Trailers	34.4	471.9
Total	41.4	561.0
Alt. 3—Preferred Alternative		
HD Pickup Trucks/Vans	7.8	94.1
Vocational Vehicles	8.3	110.3
Tractors and Trailers	56.1	769.4
Total	72.2	973.8
Alt. 4		
HD Pickup Trucks/Vans	9.3	112.8
Vocational Vehicles	10.9	143.8
Tractors and Trailers	61.6	845.2
Total	81.8	1,101.8
Alt. 5		
HD Pickup Trucks/Vans	10.8	130.5
Vocational Vehicles	17.3	226.9
Tractors and Trailers	80.7	1,108.2
Total	108.8	1,465.6

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

Results presented above are cumulative, spanning model years 2018–2029. Underlying these results are estimates of impacts for each specific model year. As an example, Table X–7 shows costs, benefits, and net benefits specific to model year 2029.

TABLE X–7—SUMMARY OF COSTS AND BENEFITS FOR MY 2029 BY ALTERNATIVE, DISCOUNTED AT 3% (RELATIVE TO BASELINE 1b), METHOD A [a]

Vehicle segment	Alt 2	Alt 3	Alt 4	Alt 5
Total Costs ($billion)				
HD pickups and Vans	0.3	0.8	0.9	1.1
Vocational Vehicles	0.3	1.5	1.5	2.9
Tractors/Trailers	1.2	1.9	1.9	3.9
Total	1.9	4.1	4.3	7.9
Total Benefits ($billion)				
HD pickups and Vans	1.9	3.6	3.8	4.2
Vocational Vehicles	1.8	5.2	5.2	7.3
Tractors/Trailers	14.4	25.4	25.4	32.0
Total	18.0	34.1	34.4	43.6
Net Benefits ($billon)				
HD pickups and Vans	1.5	2.8	2.9	3.1
Vocational Vehicles	1.4	3.7	3.7	4.4
Tractors/Trailers	13.2	23.5	23.5	28.1
Total	16.1	30.0	30.1	35.6

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

(2) Method B Tables

TABLE X–8—ANNUAL GHG AND FUEL REDUCTIONS IN 2035 AND 2050 USING METHOD B AND RELATIVE TO THE LESS DYNAMIC BASELINE [a]

	Upstream & downstream GHG reductions (MMT)		Fuel reductions (billion gallons)	
	2035	2050	2035	2050
Alt. 2 Less Stringent—Total	72	101	5.2	7.3
Tractors and Trailers	59	84	4.2	6.0
HD Pickup Trucks	8	11	0.7	0.9
Vocational Vehicles	5	7	0.3	0.5
Alt. 3 Preferred—Total	127	183	9.3	13.4
Tractors and Trailers	97	141	7.0	10.1
HD Pickup Trucks	14	19	1.1	1.6
Vocational Vehicles	16	23	1.2	1.7
Alt. 4 More Stringent—Total	132	184	9.7	13.5
Tractors and Trailers	100	141	7.2	10.1
HD Pickup Trucks	15	19	1.2	1.6
Vocational Vehicles	17	23	1.3	1.7
Alt. 5 More Stringent—Total	168	232	12.4	17.0
Tractors and Trailers	126	176	9.0	12.6
HD Pickup Trucks	17	22	1.4	1.8
Vocational Vehicles	26	34	1.9	2.5

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE X–9—BENEFIT & COST COMPARISON FOR EACH ALTERNATIVE USING METHOD B AND RELATIVE TO LESS DYNAMIC BASELINE

[Monetary values in billions of 2012$, GHG reductions in million metric tons] [a]

	Benefit-cost category	Alt 2	Alt 3	Alt 4	Alt 5
2035	Vehicle program	−$2.6	−$5.9	−$6.2	N/A
	Maintenance	−$0.06	−$0.13	−$0.14	N/A
	Fuel (pre-tax)	$20.9	$37.2	$38.7	$49.4
	Benefits	$12.8	$20.5	$21.1	$26.3
	Net benefits	$31.1	$51.7	$53.5	N/A

TABLE X–9—BENEFIT & COST COMPARISON FOR EACH ALTERNATIVE USING METHOD B AND RELATIVE TO LESS DYNAMIC BASELINE—Continued

[Monetary values in billions of 2012$, GHG reductions in million metric tons] [a]

	Benefit-cost category	Alt 2	Alt 3	Alt 4	Alt 5
	GHG reductions (MMT)	71.9	127.1	132.0	168.3
2050	Vehicle program	−$3.1	−$7.0	−$7.4	N/A
	Maintenance	−$0.06	−$0.13	−$0.14	N/A
	Fuel (pre-tax)	$31.5	$57.5	$57.6	$72.7
	Benefits	$19.9	$32.9	$32.9	$40.6
	Net benefits	$48.3	$83.2	$83.0	N/A
	GHG reductions (MMT)	101.2	183.4	183.8	231.8
NPV, 3%	Vehicle program	−$39.8	−$86.8	−$98.6	N/A
	Maintenance	−$0.88	−$1.80	−$1.91	N/A
	Fuel (pre-tax)	$280.0	$495.6	$517.6	$664.3
	Benefits	$175.2	$279.7	$289.7	$361.5
	Net benefits	$414.5	$686.8	$706.8	N/A
NPV, 7%	Vehicle program	−$19.3	−$41.1	−$48.4	N/A
	Maintenance	−$0.42	−$0.86	−$0.92	N/A
	Fuel (pre-tax)	$118.1	$206.7	$219.0	$283.0
	Benefits	$105.5	$173.5	$180.7	$228.0
	Net benefits	$203.8	$338.1	$350.5	N/A

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE X–10—BENEFIT & COST COMPARISON FOR EACH ALTERNATIVE USING METHOD B AND RELATIVE TO LESS DYNAMIC BASELINE HD PICKUP AND VANS ONLY

[Monetary values in billions of 2012$, GHG reductions in million metric tons] [a]

	Benefit-cost category	Alt 2	Alt 3	Alt 4	Alt 5
2035	Vehicle program	−$0.5	−$0.9	−$1.2	N/A
	Maintenance	−$0.01	−$0.01	−$0.01	N/A
	Fuel (pre-tax)	$2.5	$4.2	$4.4	$5.0
	Benefits	$1.4	$2.2	$2.3	$2.6
	Net benefits	$3.4	$5.5	$5.5	N/A
	GHG reductions (MMT)	8.1	13.9	14.6	16.6
2050	Vehicle program	−$0.5	−$1.0	−$1.4	N/A
	Maintenance	−$0.01	−$0.01	−$0.01	N/A
	Fuel (pre-tax)	$3.5	$6.3	$6.3	$7.2
	Benefits	$2.1	$3.5	$3.5	$4.0
	Net benefits	$5.1	$8.7	$8.4	N/A
	GHG reductions (MMT)	10.8	19.3	19.4	22.1
NPV, 3%	Vehicle program	−$7.5	−$13.5	−$19.6	N/A
	Maintenance	−$0.18	−$0.18	−$0.18	N/A
	Fuel (pre-tax)	$31.4	$53.5	$56.8	$64.9
	Benefits	$18.7	$29.2	$30.7	$34.6
	Net benefits	$42.4	$69.1	$67.7	N/A
NPV, 7%	Vehicle program	−$3.7	−$6.5	−$9.7	N/A
	Maintenance	−$0.08	−$0.08	−$0.08	N/A
	Fuel (pre-tax)	$13.1	$21.9	$23.7	$27.1
	Benefits	$11.4	$18.2	$19.3	$21.8
	Net benefits	$20.7	$33.5	$33.2	N/A

Note:
[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE X–11—BENEFIT & COST COMPARISON FOR EACH ALTERNATIVE USING METHOD B AND RELATIVE TO LESS DYNAMIC BASELINE VOCATIONAL VEHICLES ONLY

[Monetary values in billions of 2012$, GHG reductions in million metric tons] [a]

	Benefit-cost category	Alt 2	Alt 3	Alt 4	Alt 5
2035	Vehicle program	−$0.2	−$2.1	−$2.1	N/A
	Maintenance	−$0.02	−$0.03	−$0.04	N/A
	Fuel (pre-tax)	$1.3	$4.7	$5.1	$7.6
	Benefits	$1.1	$2.6	$2.8	$3.9

TABLE X–11—BENEFIT & COST COMPARISON FOR EACH ALTERNATIVE USING METHOD B AND RELATIVE TO LESS DYNAMIC BASELINE VOCATIONAL VEHICLES ONLY—Continued

[Monetary values in billions of 2012$, GHG reductions in million metric tons][a]

	Benefit-cost category	Alt 2	Alt 3	Alt 4	Alt 5
	Net benefits	$2.2	$5.2	$5.8	
	GHG reductions (MMT)	4.7	16.1	17.4	25.8
2050	Vehicle program	−$0.3	−$2.4	−$2.4	N/A
	Maintenance	−$0.02	−$0.03	−$0.04	N/A
	Fuel (pre-tax)	$2.0	$7.3	$7.3	$10.7
	Benefits	$1.7	$4.2	$4.2	$5.9
	Net benefits	$3.4	$9.0	$9.1	N/A
	GHG reductions (MMT)	6.5	23.2	23.3	33.9
NPV, 3%	Vehicle program	−$3.6	−$29.6	−$32.8	N/A
	Maintenance	−$0.22	−$0.42	−$0.52	N/A
	Fuel (pre-tax)	$16.9	$60.6	$66.3	$99.9
	Benefits	$14.8	$34.8	$37.4	$52.7
	Net benefits	$27.9	$65.4	$70.3	N/A
NPV, 7%	Vehicle program	−$1.7	−$13.8	−$16.0	N/A
	Maintenance	−$0.10	−$0.19	−$0.24	N/A
	Fuel (pre-tax)	$6.9	$24.7	$27.9	$42.5
	Benefits	$8.3	$21.5	$23.4	$33.8
	Net benefits	$13.4	$32.2	$35.0	N/A

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

TABLE X–12—BENEFIT & COST COMPARISON FOR EACH ALTERNATIVE USING METHOD B AND RELATIVE TO LESS DYNAMIC BASELINE TRACTOR/TRAILERS ONLY

[Monetary values in billions of 2012$, GHG reductions in million metric tons][a]

	Benefit-cost category	Alt 2	Alt 3	Alt 4	Alt 5
2035	Vehicle program	−$1.9	−$2.9	−$2.9	N/A
	Maintenance	−$0.03	−$0.08	−$0.08	N/A
	Fuel (pre-tax)	$17.2	$28.4	$29.2	$36.8
	Benefits	$10.3	$15.7	$16.0	$19.7
	Net benefits	$25.6	$41.0	$42.2	N/A
	GHG reductions (MMT)	59.1	97.2	100.0	125.9
2050	Vehicle program	−$2.3	−$3.6	−$3.6	N/A
	Maintenance	−$0.03	−$0.08	−$0.08	N/A
	Fuel (pre-tax)	$26.1	$44.0	$44.0	$54.8
	Benefits	$16.1	$25.2	$25.2	$30.7
	Net benefits	$39.9	$65.5	$65.6	N/A
	GHG reductions (MMT)	83.8	140.9	141.1	175.7
NPV, 3%	Vehicle program	−$28.8	−$43.7	−$46.2	N/A
	Maintenance	−$0.47	−$1.19	−$1.22	N/A
	Fuel (pre-tax)	$231.7	$381.5	$394.5	$499.5
	Benefits	$141.7	$215.7	$221.6	$274.2
	Net benefits	$344.1	$552.3	$568.8	N/A
NPV, 7%	Vehicle program	−$13.9	−$20.9	−$22.7	N/A
	Maintenance	−$0.23	−$0.59	−$0.60	N/A
	Fuel (pre-tax)	$98.1	$160.1	$167.5	$213.4
	Benefits	$85.8	$133.8	$138.1	$172.4
	Net benefits	$169.8	$272.4	$282.3	N/A

Note:

[a] For an explanation of analytical Methods A and B, please see Section I.D; for an explanation of the less dynamic baseline, 1a, and more dynamic baseline, 1b, please see Section X.A.1.

XI. Natural Gas Vehicles and Engines

Both gasoline and diesel vehicles can be designed or modified to use natural gas. NGV America estimates that approximately 0.5 percent of the heavy-duty vehicle fleet use natural gas. A small but growing number of medium and heavy-duty natural gas vehicles have been produced and are in current use. Although these natural gas versions are similar in many ways to their petroleum counterparts, there are significant differences. There are also both similarities and differences in the production and distribution of natural gas relative to gasoline and diesel fuel.

This combined rulemaking by EPA and NHTSA is designed to regulate two separate characteristics of heavy duty vehicles: Emissions of GHGs and fuel consumption. The use of natural gas as a heavy-duty fuel can impact both of these. In the case of diesel or gasoline powered vehicles, there is a close relationship between these two characteristics. For natural gas fueled vehicles, which reduce or eliminate the use of petroleum, the situation is different. For example, a natural gas vehicle that achieves approximately the same fuel efficiency as a diesel powered vehicle would emit about 20 percent less CO_2 when operating on natural gas; and a natural gas vehicle with the same fuel efficiency as a gasoline vehicle would emit about 30 percent less CO_2. In Phase 1, the agencies balanced these facts by applying the gasoline and diesel CO_2 standards to natural gas engines based on the engine type of the natural gas engine. Fuel consumption for these vehicles is then calculated according to their tailpipe CO_2 emissions. In essence, this applies a one-to-one relationship between fuel efficiency and tailpipe CO_2 emissions for all vehicles, including natural gas vehicles. The agencies determined that this approach would likely create a small balanced incentive for natural gas use. See 76 FR 57123; see also 77 FR 51705 (August 24, 2012) and 77 FR 51500 (August 27, 2012) (EPA and NHTSA, respectively, further elaborating on basis for having Phase 1 apply at the tailpipe only, including for alternative fueled vehicles); see also *Delta Construction Co.* v. *EPA,* 783 F. 3d 1291 (D.C. Cir. 2015) U.S. App. LEXIS 6780, F.3d (D.C. Cir. April 24, 2015) (dismissing challenge to Phase 1 GHG standards as being arbitrary for applying only on a tailpipe basis).

For Phase 2, the agencies have reevaluated the potential use of natural gas in the heavy-duty sector and the impacts of such use. As discussed below, based on our review of the literature and external projections we believe that the use of natural gas is unlikely to become a major fuel source for medium and heavy-duty vehicles during the Phase 2 time frame. Thus, since we project natural gas vehicles to have little impact on both overall GHG emissions and fuel consumption during the Phase 2 time frame, the agencies see no need to propose fundamental changes to the Phase 1 approach for natural gas engines and vehicles.

In the following sections, we present a lifecycle analysis of natural gas used by the heavy-duty truck sector. We also present the results of an analysis by the Energy Information Administration projecting the future use of natural gas by heavy-duty trucks. Finally, we list a number of potential technologies and discuss the approaches that could be pursued help to reduce the methane emissions from natural gas trucks. A more detailed discussion of these analyses and issues can be found in the draft RIA.

A. Natural Gas Engine and Vehicle Technology

Several engine parameters and characteristics come into play in comparing engines powered by natural gas with engines powered by conventional fuels.

Gasoline-fueled engines are typically spark-ignition engines that rely on stoichiometric combustion, which means that essentially all the oxygen from the engine's intake air is consumed in the combustion process. Converting a gasoline-fueled engine to run on natural gas involves changing the hardware used to store and deliver fuel to the engine, but the combustion strategy remains largely unchanged. The engine must be recalibrated for the different fuel properties, but combustion remains stoichiometric. In addition, the catalysts may require significant changes to enable the heavy-duty engine to comply with the emission standards.

Diesel-fueled engines are compression-ignition engines that rely on lean-burn combustion, which means that the engine takes in a substantial quantity of excess air (oxygen) that is not consumed in the combustion process. Engines usually have turbochargers to compress the intake air, which allows for greater power output and thermodynamic efficiency. Converting a diesel-fueled engine to run on natural gas may involve a minimal set of changes to engine calibrations to maintain lean-burn operation and the overall operating characteristics of a compression-ignition engine, although there would be substantial changes to the fuel storage and delivery systems. This could require the use of a pilot injection of a small amount of diesel fuel to initiate the combustion event, or more commonly, a mixture (never more than 50 percent natural gas) of natural gas and diesel fuel is combusted. It is also possible to convert a diesel-fueled engine to run on natural gas by adding a spark plug and changing the calibration strategy to rely on stoichiometric combustion. This allows for simpler engine design and operation, but comes at a cost of higher fuel consumption and CO_2 emissions.

Engines running on natural gas are capable of meeting the same criteria and GHG emission standards that apply for gasoline and diesel engines. In the case of reducing PM and CO_2 emissions, there is an inherent advantage for natural gas. In contrast, engines must be properly calibrated and maintained to avoid high emission rates for NO_X, HC, and CO.

On-vehicle fuel storage for natural gas is also an important design parameter. The most common method today is compressed natural gas (CNG), which involves storing the fuel as a gas at very high pressure (up to ~3500 psi) to increase the density of the fuel. This increases vehicle weight and generally reduces the range relative to gasoline or diesel vehicles, but the technology is readily available and does not involve big changes for operators. The alternative is to cool the fuel so that it can be stored as liquefied natural gas (LNG), which involves more extensive hardware changes for managing the fuel as a cryogenic liquid. LNG fuel storage also involves a substantial weight increase, but LNG has a higher density than CNG so LNG vehicles can store much more fuel than CNG vehicles in the same volume. LNG technology is available for a limited number of truck models, mostly for line-haul service where range is a paramount consideration. The cryogenic fuel requires substantial changes in hardware and procedures for refueling stations and operators. An additional factor in considering LNG technology is that a parked vehicle could vent the fuel as it takes on heat from the surrounding environment over a period of several days.

B. GHG Lifecycle Analysis for Natural Gas Vehicles

This section is organized into three sections. The first section summarizes the upstream emissions. The second section summarizes the downstream emissions. The last section summarizes the results of the lifecycle emissions and provides a comparison between natural gas lifecycle and diesel fuel lifecycle emissions. Only the overall results of the lifecycle emissions comparison between natural gas and diesel fuel are presented here, much more detail is provided in Chapter 13 of the DRIA.

(1) Upstream Emissions

Upstream methane emissions, occurring in the natural gas production, natural gas processing, transmission, storage and distribution stages of natural gas production, are estimated and summarized in the annual EPA report Inventory of U.S. Greenhouse Gas Emissions and Sinks (GHG Inventory) for the United Nations Framework Convention on Climate Change (UNFCCC). As a basis for estimating the life-cycle impact of natural gas use by heavy-duty trucks, we used the year 2012 methane emission estimates in the most recent GHG Inventory, published in 2014. The GHG Inventory also includes the quantity of carbon dioxide which is coproduced with methane throughout the natural gas system and emitted to the atmosphere through venting, flaring, and as fugitive emissions.

The GHG Inventory is updated annually to account for new emission sources (*e.g.,* new natural gas wells), updated data, emission factors and/or methodologies, and to account for changes in emissions due to policy changes, regulatory changes and changes in industry practices. The GHG Inventory reflects emission reductions due to existing state regulations, National Emission Standards for Hazardous Air Pollutants (NESHAP) promulgated by EPA in 1999, the New Source Performance Standards (NSPS) promulgated by EPA in 2012,[793] and Natural Gas Star (a flexible, voluntary partnership that encourages oil and natural gas companies to adopt proven, cost-effective technologies and practices that improve operational efficiency and reduce methane emissions).[794]

Emission estimates in the GHG Inventory are generally bottom-up estimates which are per-unit (compressor, pneumatic valve, etc.) emission estimates based on measured or calculated emission rates from such emission sources.

In addition to the national-level data available through the GHG Inventory, facility-level petroleum and natural gas systems data are also available through EPA's Greenhouse Gas Reporting Program (GHGRP). This data represents a significant step forward in understanding GHG emissions from this sector and EPA expects that this data will be an important tool for the agency and the public to analyze emissions, and understand emission trends. For some sources, EPA has already used GHGRP data to update emission estimates in the GHG inventory, and EPA plans to continue to leverage GHGRP data to update future GHG Inventories.

The EPA-promulgated 2012 New Source Performance Standards (NSPS) will reduce emissions of ozone precursors from natural gas facilities and have methane and hazardous air pollutant reduction co-benefits. The NSPS standards require that natural gas wells which are hydraulically fractured control emissions using flaring or reduced emission completion (REC) technology from completions and workovers starting in 2012. RECs used by natural gas well drillers capture the natural gas emissions that occur during well completion, instead of venting or flaring the emissions. Starting January 2015, RECs are required for natural gas well completions and workovers. The NSPS also regulates the emissions from certain new natural gas production equipment, including dehydrator vents and condensate tanks. In the 2013 Climate Action Plan, EPA projects future emissions of methane to increase modestly, by about 4 percent between now and 2025. As estimated for the recent power plant proposed rulemaking, natural gas production is expected to increase by about 20 percent during this timeframe, thus, methane emissions in 2025 are expected to be 14 percent lower than in 2012 based on an equivalent volume of natural gas being produced. As announced by the White House, EPA will further regulate methane emissions from new natural gas production facilities.[795] [796]

In the GHG Inventory, emissions associated with powering the units or equipment (*i.e.,* compressors, pumps) used in natural gas production, processing, transmission and distribution are aggregated with all the other fossil fuel combustion activities. Rather than attempt to disaggregate those specific GHG emissions from the rest of the process emissions in the GHG Inventory, we instead used the estimated emissions for these sources provided by GREET.

(2) Downstream Emissions

Natural gas can be used by vehicles either as a compressed gas (CNG) or as liquefied natural gas (LNG). We discuss the emissions of both below.

(a) Compressed Natural Gas (CNG)

The natural gas that comprises CNG is typically off-loaded from the natural gas system where the vehicles using CNG are refueled. This is because the natural gas used as CNG is compressed at the retail stations that sell the CNG and the fleet facilities which fuel the CNG fleet vehicles. To get the natural gas to the CNG retail facilities which are mostly located in or near urban areas, the natural gas is expected to be shipped through the distribution system downstream of the natural gas transmission system. CNG trucks are then refueled at the retail stations providing CNG. Each time a CNG refueling event occurs, a small amount of natural gas is released to the environment. Because of a lack of data or an estimate by GREET or CARB, this small amount of natural gas has not been estimated and therefore are not included in the lifecycle analysis presented here. Since these systems are designed to have no leaks, the CNG could remain stored in the CNG tanks indefinitely. However, the very high pressure at which CNG is stored dramatically increases fugitive emissions if a fitting were to develop a leak. The level of fugitive emissions for a certain sized hole is directly proportional to the pressure. We do not have any data on the fugitive emissions from CNG trucks. In our lifecycle analysis, we assume that CNG fugitive emissions are zero, which likely underestimates the methane emissions.

When CNG is stored at high pressure (*i.e.,* 3600 psi) it contains only about 25 percent the energy density of diesel fuel. This low fuel storage density is a disincentive for using CNG in long haul trucks. An adsorbent for natural gas (ANG),[797] called metal organic framework (MOF) for storing CNG, has been invented and is being tested for large scale use. The technology involves filling the CNG tank with a specially designed substance that looks similar to a pelletized catalyst. The substance establishes a matrix which causes the methane molecules to become better organized and store the same quantity of natural gas in a smaller volume at the same pressure (about 60 percent of the energy density of diesel fuel), or store the same density of natural gas at a lower pressure. This MOF could improve the energy density of CNG which would make it a better candidate for natural gas storage for long range combination trucks. Or, if used to store CNG at the same density, could reduce the compression energy required to compress the CNG since it could be stored at a lower pressure.

(b) Liquified Natural Gas (LNG)

A primary reason for liquefying natural gas is that it allows storing the natural gas at about 60 percent of the density of diesel fuel. For this reason, LNG is a primary fuel being considered by long haul trucks.

[793] Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews; Final Rule, 40 CFR parts 60 and 63, Environmental Protection Agency, August 16, 2012.

[794] *www.epa.gov/gasstar/.*

[795] FACT SHEET: Administration Takes Steps Forward on Climate Action Plan Announcing Actions to Cut Methane Emissions, The White House, January 14, 2015.

[796] FACT SHEET; EPA's Strategy for Reducing Methane and Ozone-Forming Pollution from the Oil and Natural Gas Industry; Environmental Protection Agency, January 14, 2015.

[797] Menon, V.C., Komarneni, S. 1998 ''Porous Adsorbents for Vehicular Natural Gas Storage: A Review'', Journal of Porous Materials 5, 43–58 (1998); Burchell, T ''Carbon Fiber Composite Adsorbent Media for Low Pressure Natural Gas Storage'' Oak Ridge National Laboratory.

The first step downstream of the natural gas production, processing and distribution system for making LNG available to trucks is the liquefaction step. This step involves the removal of heat from the natural gas until it undergoes a phase change from a gas to a liquid at a low pressure. LNG plants are configured depending on their ultimate capacity. World class LNG plants produce 5 million metric tons, or more, per year of LNG and the economy of scale of these large plants supports the significant addition of capital to reduce their operating costs and energy use. An LNG plant solely producing LNG for truck fuel is expected to be significantly smaller than the world class LNG export plants with a poorer economy of scale. Their energy efficiency would be expected to be much lower on a percentage basis. The California Air Resources Board estimates the liquefaction plants used for producing truck LNG fuel are 80 percent efficient, compared to 90 percent efficient for world class LNG plants.[798] In our lifecycle analysis of LNG as a truck fuel, we also assumed that LNG plants are 80 percent efficient. The LNG producer is not only responsible for the LNG fugitive emissions at the plant, but it is also responsible for the GHG and other process emissions emitted when liquefying the natural gas. Because LNG plants are located separate from the retail facilities, they can be located to access the lowest cost feedstock. This means the natural gas for LNG can be sourced from the larger natural gas transmission pipelines which are upstream of the distribution pipelines. Once the natural gas is liquefied at the liquefaction plant, it is stored in an insulated storage tank to keep the LNG liquefied.

To transport the LNG to the retail station, the LNG is loaded into an insulated horizontal trailer designed specifically for transporting LNG. If the LNG in the truck trailer were to warm sufficiently to cause the LNG to reach the pressure relief valve venting pressure, there would be boil-off emissions from the truck trailer. However, since the LNG is super cooled, boil off events are likely to be rare. We did not have access to any specific data to estimate these emissions so we used a CARB estimate of boil-off emissions for LNG transportation by the tanker truck between the LNG plant and retail outlets.[799]

LNG is stored in an insulated storage tank at the retail facility. Heat gain in the storage tank could eventually lead to boil-off emissions. Service stations with little LNG demand are at a higher risk of boil-off emissions compared to service stations which have a significant throughput volume. LNG stations could be configured to avoid boil-off events to the atmosphere, such as venting to a co-located CNG facility, or venting to a nearby natural gas pipeline. We did not have access to any specific data to estimate these emissions so we used a CARB emission estimates for the boil-off emissions from LNG retail facilities.[800]

Vehicles requiring LNG fuel drive up to an LNG retail outlet or fleet refueling facility and fill up with LNG fuel. When the refueling nozzle is disconnected from the LNG tank nozzle, a small amount of methane is released to the environment. In addition, it may be necessary prior to refueling, due to high pressure in the truck's LNG tank, to reduce the pressure in the truck's LNG tank to speed up the refueling process. In some cases the retail station is equipped with another hose and associated piping to vent the excess gas to the retail stations' storage tank where it would usually condense back to a liquid due to the lower temperature of that tank, or perhaps be vented to a natural gas pipeline. However, for those retail outlets without such vent lines to the storage tank, the truck driver may simply vent the truck's storage tank to the atmosphere. As part of a sensitivity analysis for our lifecycle analysis, we estimate the emissions for venting an LNG tank prior to refueling.

(c) Comparing CNG to LNG

There is an important difference in providing CNG and LNG which is important to highlight. For making CNG available to trucks, only a single facility, the retail outlet, is required for distributing CNG, while LNG requires both a liquefaction plant and a retail outlet and a means for transporting the LNG from the liquefaction plant to retail. Relying on a single facility simplifies the logistics of providing CNG and reduces the opportunity for methane leakage to the environment. However, this emissions disadvantage of LNG compared to CNG is offset somewhat because LNG is expected to access the lower priced natural gas from the upstream transmission system, therefore, the methane emissions associated with the downstream natural gas distribution system are avoided.

(d) Vehicle Emissions

There are several different ways that diesel heavy duty engines can be configured to use natural gas as a fuel. The first is a spark ignition natural gas (SING), Otto cycle SING heavy duty engine burns the fuel stoichiometrically and uses a three-way catalyst, and some also add an oxidation catalyst to provide the greatest emissions reduction. In this case the engine compression ratio is reduced similar to that of a gasoline engine and thus its thermal efficiency is lower than a diesel-like engine by about 10–15 percent.

The second is a direct injection natural gas (DING), diesel cycle. The DING engine uses a small quantity of diesel fuel (pilot injection) or a glow plug as ignition sources. As the injection system for the diesel fuel does not have the capability of greater injection quantities, this option has no dual-fuel properties. On the other hand, an optimization of the pilot injection can be made to achieve lower emissions. An advanced high pressure direct injection (HPDI) fuel system combining the injection of both diesel fuel and natural gas can be used for lean burn combustion. This enables the engine to maintain the efficiency advantage of a compression ignition engine while running mainly CNG/LNG.

The third is a mixed-fuel natural gas (MFNG), diesel cycle. In a mixed-fuel engine, natural gas is mixed with intake air before induction to the cylinder and diesel fuel is used as ignition source. Mixed-fuel vehicle/engine means any vehicle/engine engineered and designed to be operated on the original fuel(s), or a mixture of two or more fuels that are combusted together. Engine results showed that the efficiency of the engine could decrease by about 2–5 percent in mixed-fuel mode compared to diesel mode and that the diesel replacement was approximately 40–60 percent.

Each of these natural gas engine types has its merits. The SING engine is less costly, but is less fuel efficient and because of the lower compression ratio it has less torque than the two diesel cycle engines. The DING engine is likely the most expensive because of the special natural gas/diesel fuel injection system and large required amount of natural gas (LNG or CNG) storage since the truck must run on natural gas. However, because the truck can run almost completely on natural gas, the DING engine has the potential to more quickly pay down the higher investment cost of the natural gas truck. The MFNG engine provides the truck owner the

[798] Detailed California-Modified GREET Pathway for Liquid Natural Gas (LNG) from North American and Remote Natural Gas Sources, Version 1.0, California Air Resources Board, July 20, 2009.

[799] Ibid.

[800] Ibid.

flexibility to operate on natural gas or diesel fuel, but at the expense of a slower natural gas investment pay down rate because it can operate at most 50 percent of the time on natural gas.

When assessing the methane emissions from both CNG and LNG trucks, it is important to separate those trucks built or converted before 2014 to those built or converted in 2014 and later. The trucks built before 2014 only needed to meet a nonmethane hydrocarbon (NMHC) standard, which means that the methane emissions from these trucks are unregulated. Our certification data show that the methane tailpipe emissions from these trucks/buses ranges from 2–5 g/bhp-hr for both spark ignition (gasoline type) and compression ignition (diesel type) engines.

For 2014 and later OEM compression ignition natural gas trucks or natural gas conversions of 2014 and later diesel trucks, the trucks must meet a 0.1 g/bhp-hr methane emission standard in the case of a larger truck engine tested with an engine dynamometer, and a 0.05 g/mile methane emission standard in the case of smaller trucks tested on a chassis dynamometer. For spark ignition (gasoline style) engines, the standards take effect in 2016.[801] Natural gas truck manufacturers are allowed to offset methane emissions exceeding the methane emission standard by converting the methane emission exceedances into CO_2 equivalent emissions and using CO_2 credits. For the initial natural gas engine certifications that EPA received for 2014, the truck manufactures chose to continue to emit high levels of methane (around 2 g/bhp-hr) and use carbon dioxide credits to offset those emissions. We don't know if this practice of will continue in the future, however, for evaluating the lifecycle impacts of natural gas heavy-duty trucks, the 2014 and later natural gas heavy-duty trucks may in fact have an emissions profile more like the pre-2014 trucks and not like the 2014 and later trucks as depicted below in the figures. It is worth noting that the potential exists for deterioration or malfunction of the engines, fuel supplies, or associated emission control devices on these trucks to occur in such a manner to result in higher methane emissions in actual use. We have not specifically accounted for the potential for increased methane emissions caused from high emitter natural gas trucks. See generally Section II above.

The crankcase of these engines receives leakage from across the piston rings, which can contain methane. The crankcase of the spark ignition engines is normally vented into the intake of the engines, thus, any methane emissions from the crankcase which is not combusted in the engine would be accounted for in the tailpipe emissions. For compression ignition engines, however, the crankcase emissions are allowed to be vented into the exhaust pipe downstream of the aftertreatment devices, and therefore the crankcase emissions are released to the atmosphere even though they are included in the emissions test for the Methane standard that was introduced in Phase 1 on the rule. Another potential source of methane emissions from CNG and LNG trucks is fugitive emissions from the engine and the piping which routes the fuel to the engine. Thus, either while parked or operated, this part of the vehicle fuel and engine systems could leak methane to the environment (which is different from boil-off emissions from LNG trucks discussed below). We do not have data nor did we develop an estimate for these potential fugitive emissions from these types of in-use leaks. If the natural gas vehicles are well maintained, these emissions are likely to be very low.

The thermal efficiency (the ratio of energy converted to work versus energy consumed) of the natural gas engine also plays a role in the lifecycle emissions of the truck. Natural gas engines are generally less efficient than their gasoline and diesel counterparts. Furthermore, manufacturers choose to produce spark-ignition stoichiometric natural gas engines for use in diesel applications. Spark-ignition natural gas engines can be as much as 15 percent less efficient than compressed ignition engines which operate on diesel fuel. In our lifecycle analysis, we provide two different sensitivities for natural gas vehicles assuming that they may be 5 percent and 15 percent less efficient.

An important difference between CNG and LNG is way in which the fuels are stored on the vehicle. The CNG is contained in a sealed system while the LNG system is ultimately open to the environment. Providing that there are no leaks in the storage system, the CNG truck is inherently low (zero) emitting and a parked truck would contain the CNG indefinitely. An LNG truck is inherently high emitting since if the truck were to be parked long enough its entire contents would be emitted to the environment.

Thus, a major GHG issue for LNG trucks is boil-off emissions from the truck's fuel storage systems. When the liquefied natural gas is pumped into the truck LNG tanks, it is ''supercooled,'' meaning that the pressure of the LNG is well below the pressure at which the natural gas vent valve would relieve the LNG pressure. If the truck is driven extensively, the drawdown of liquid level will cause a vacuum which will cause some of the fuel to boil off and the heat of vaporization would thus cool the rest of the liquid in the LNG storage tank. It is possible that the fuel would maintain its supercooled temperature, or possibly even cool further below its supercooled temperature, the entire time until the LNG is completely consumed.

If the truck is not driven at all or is driven very little, the very low temperature and low pressure LNG warms due to the ambient temperature gradient through the tank wall, and vaporizes, causing the temperature and pressure of the LNG to rise. When the pressure reaches a maximum of 230 psi a safety release valve releases the methane gas to vent excess pressure. There are two industry standards used to design tanks to reduce the temperature increase, one for a 3 day hold time[802] and one for a 5 day hold time.[803] Hold time is the time elapsed between the LNG refueling and venting.

If there is a boil-off event, a large amount of methane would be released. If aware of the impending boil-off, such as when the truck is being maintained, the truck driver could hook up the LNG tank to a hose which would vent the natural gas emissions to a CNG system which could reuse the boil-off natural gas as CNG, or vent the natural gas emission to a natural gas pipeline. Otherwise the boil-off emission would simply vent to the atmosphere. If the truck had 200 gallons of LNG storage capacity, the estimated quantity of boil-off emissions would range from 3 to 9 gallons of LNG for each boil off event depending on the fill level of the LNG tank. Each boil off event has the potential to release on the order of 5,300–15,800 grams of CH_4 which equates to 132–400K grams of CO_2 equivalent emissions, assuming that methane has a global warming potential (GWP) of 25 (assessed over 100 years). If the vehicle continues to sit for five more days and boil-off events occur each day to several times per day as the tank vents and rebuilds in pressure, the sum total of the boil-off events can

[801] See 76 FR 57192, 40 CFR 1036.108(a)(2) and 1037.104(c) (which is proposed to be redesignated as 40 CFR 86.189–14(k)(5)).

[802] National Fire Protection Association 52, Compressed Natural Gas (CNG) Vehicular Fuel System Code, 2002 Edition.

[803] SAE International (2008) SAE J2343: Recommended Practice for LNG Medium and Heavy-Duty Powered Vehicles. Warrendale, Pennsylvania.

result in over a million grams of CO_2-equivalent emissions.

(3) Results of Life Cycle Analysis

To estimate the lifecycle impact of natural gas used by heavy-duty trucks, we totaled the carbon dioxide, methane (CH_4) and the nitrous oxide (N_2O) emissions for the upstream and downstream portions of the natural gas system. The methane and nitrous oxide emissions are converted to carbon dioxide-equivalent emissions using the appropriate GWP conversion factors. The GWP conversion factors EPA currently uses are for a 100-year timeframe, are 25 and 298 for methane and nitrous oxide, respectively.[804]

To establish the impacts of natural gas use in the heavy-duty fleet, it was necessary to compare the lifecycle impacts of natural gas against the base fuel it is replacing, which is diesel fuel. The lifecycle impact of diesel fuel was estimated by the National Energy Technology Laboratory (NETL) for the production and use of diesel fuel in 2005. EPA used this lifecycle assessment for the 2010 Renewable Fuel Standard Rulemaking and we are using this NETL diesel fuel lifecycle estimate as the reference for comparison with the natural gas lifecycle assessment. NETL is in the process of revising its lifecycle analysis of diesel fuel to 2009, which should be available sometime in 2015. According to the lead analyst, the 2009 lifecycle analysis appears to be similar in magnitude to the 2005 analysis.[805] However, the 2009 analysis will not capture the lifecycle effects of the large increase in hydraulically fractured crude oil (*i.e.,* Bakken, Eagle Ford) which has occurred in the U.S. during the first part of this decade.

To illustrate the relative full lifecycle impact of natural gas-fueled heavy-duty vehicles compared to diesel fueled heavy-duty vehicles, we assessed several different scenarios. The first is a conversion of a diesel engine to use compressed natural gas. Of the tens of thousands of heavy-duty natural gas trucks currently in use, over 90 percent are of this type. These are conversions of older trucks so they are not regulated by the 2014 methane standard. For future year heavy-duty trucks, we also estimated the lifecycle emissions if the trucks were meeting a 0.1 g/bhp-hr or a 0.05 g/mile methane tailpipe standard. We provide two sensitivities to capture the lower thermal efficiencies of natural gas trucks: 5 percent less thermally efficient (thermal low) and 15 percent less energy efficient (thermal high, which is 10 percent worse thermal efficiency than the 5 percent less thermally efficient case). The relative life cycle assessment is shown in Figure XI–1.

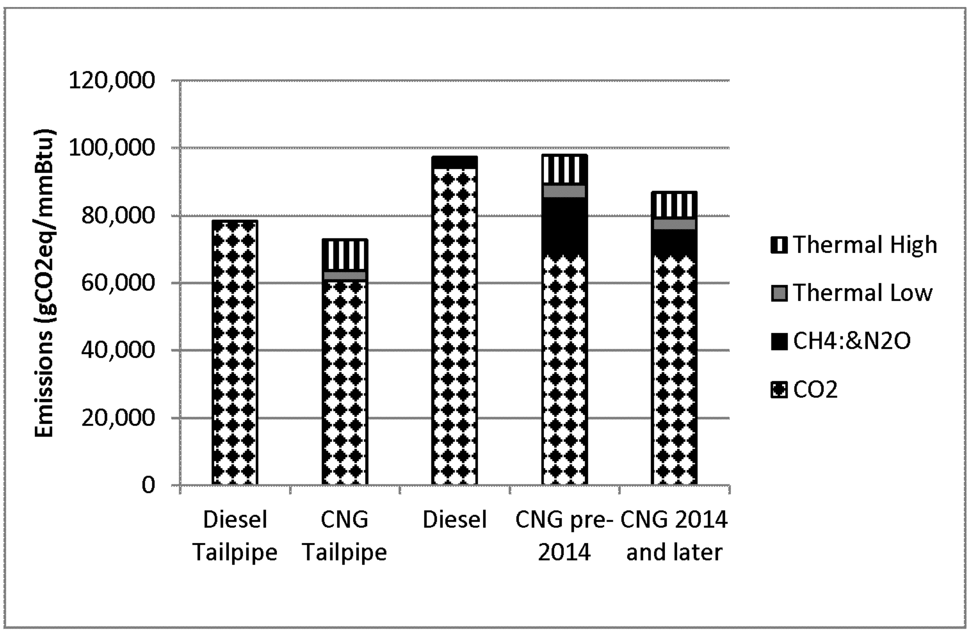

Figure XI-1 Full Lifecycle Analysis (except tailpipe only emissions) of a CNG Truck

(Projected Upstream Methane Emissions in 2025, methane GWP of 25)

The first two bars of Figure XI–1 show that based solely on CO_2 tailpipe emissions (with and without thermal efficiency adjustments and assuming no increased methane emissions at the truck), CNG trucks are estimated to emit about 20 percent less GHG emissions than diesel engines. But this advantage decreases if the natural gas engine is less thermally efficient. The three full lifecycle analyses represented by the right three bars in the figure show that pre-2014 CNG trucks are estimated to emit less GHG emissions as diesel trucks, although if their thermal efficiency is much lower (15 percent less than the diesel fueled engine) they could emit about the same GHG emissions. When such trucks are complying with the 2014 and later methane emission standards, their methane emissions are much lower and these trucks are expected to be lower emitting than diesels, even if they are less thermally efficient.

The second scenario presented in Figure X1–2 is a combination LNG truck

[804] These global warming potential values are based on the Fourth Assessment Report authored by the Intergovernmental Panel on Climate Change.

[805] Conversation with Timothy J. Skone P.E., National Energy Technology Laboratory, Department of Energy, June 2014.

which in one case is assumed to be emitting methane at pre-2014 emission standards and in another case is assumed to comply with the 2014 methane standard. It is an OEM natural gas truck with a high pressure direct injection engine, and because of the extensive mileage, the truck most realistically would use LNG as a fuel to provide the necessary range for the dedicated natural gas engine. We make two different assumptions with respect to refueling and boil off emissions. In the LNG average case, we assume a modest quantity of refueling and boil-off methane emissions which is estimated by GREET. The second boil-off emission estimate (assumed to be complying with the 2014 methane emission standard) is based on venting the LNG storage tank to the atmosphere each time the driver refills his tank, and one LNG boil-off event between each time the driver must refuel his tank. As discussed above, we do not expect such high refueling and boil-off emissions to be common practices for newer trucks that are operated regularly. However, as the use of these trucks decreases as they age and are sold into the secondary market, the risk for refueling and boil-off emission events increases—this estimate provides a simple sensitivity emission estimate. The lifecycle assessment is shown in Figure XI–2.

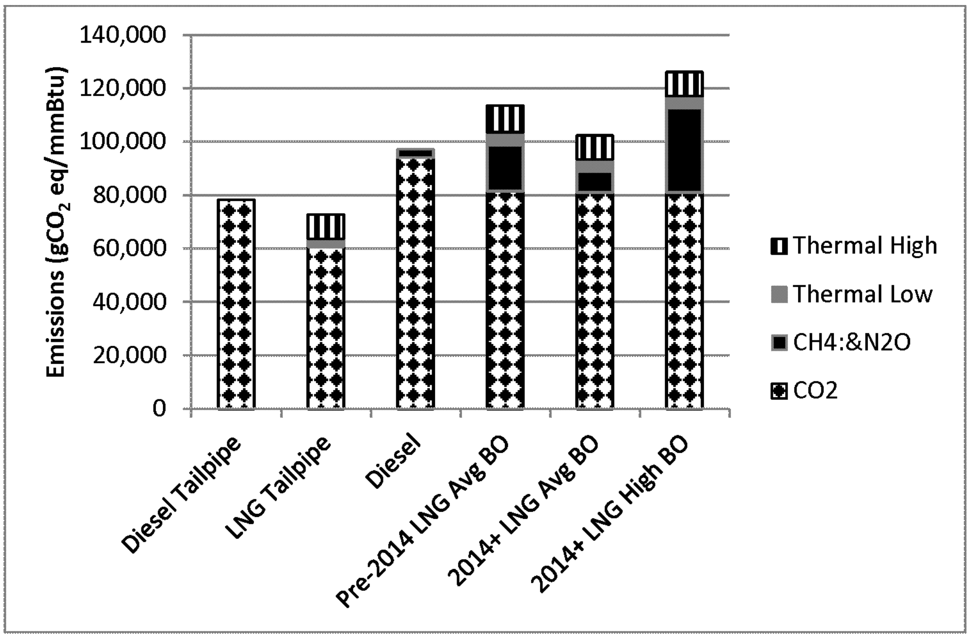

Figure XI-2 Full Life Cycle Analysis (except tailpipe only emissions) of an LNG Truck

(Projected Upstream Methane Emissions in 2025, Low and High Refueling and Boil-Off Emissions,

Methane GWP of 25)

Figure XI–2 shows that LNG trucks have about the same greenhouse gas footprint as diesel trucks providing that they are complying with the methane emission standard and providing we assume a low quantity of refueling and boil-off emissions. In comparing CNG to LNG, the LNG trucks appear higher emitting than CNG trucks because of the low thermal efficiency of the small liquefaction facilities. If these LNG trucks emit high levels of methane when refueling and by experiencing boil-off events or if they emit methane at pre-2014 emission standard levels, their GHG emissions can potentially be much greater than that from diesel trucks.

It is important to point out the uncertainties associated with the lifecycle estimates provided in the above figures. As discussed above, there is uncertainty in both the upstream and downstream methane emission estimates for natural gas facilities and equipment, and the trucks that consume natural gas. There is also uncertainty in the diesel fuel lifecycle analysis conducted by NETL. As new information becomes available, we can update our lifecycle emission estimates which would reduce the uncertainty of this analysis. A number of studies are being conducted to quantify the methane emissions (upstream and downstream) and life cycle impacts of natural gas by the Environmental Defense Fund (EDF). The final reports for these studies have not yet been released but we will review them once they are available. Finally, the lifecycle analysis is sensitive to the GWP factor used to assess methane and nitrous oxide, and if a different GWP value were to be used, it would affect the relative lifecycle impact of natural gas relative to diesel in heavy-duty trucks (see Chapter 13 of the draft RIA for sensitivity analyses regarding upstream methane emissions and the use of different GWP factors).

We compared our lifecycle emission estimates for natural gas, relative to diesel fuel, with the estimates provided by the California Air Resources Board (CARB) for its Low Carbon Fuel Standard (LCFS). For our emissions estimate used in the comparison we used the carbon dioxide-equivalent (CO_2 eq) emissions estimated for 2014 and later engines, which must comply with a methane tailpipe emissions standard, and assumed that the engine was 5 percent less thermally efficient than a comparable diesel engine. For the CARB emissions estimates, we used the estimates made for illustrative purposes using the 2013 version of the CARB GREET model as published in August, 2014.[806] [807] CARB estimates that CNG engines emit 76 percent of the CO_2 eq emissions as a diesel truck, while our analysis estimates that CNG engines emit 81 percent of the CO_2 eq emissions as a diesel truck. The most likely explanation for CARB's lower estimated CO_2 eq emissions for CNG engines is that a much larger portion of the electricity used to compress natural gas is renewable in California than the rest of the country. CARB estimates LNG engines emit 94.5 percent of the CO_2 eq emissions as a diesel truck while our analysis estimates LNG trucks emit 96 percent of the CO_2 eq emissions as a diesel truck. CARB assumes no boil-off or venting emissions for LNG trucks and for this comparison, we used our more modest boil-off and venting assumption, as described above, which is close to CARB's. Overall, our estimates are very similar to those estimated by CARB and when there are differences, the differences are as expected.

A UC Davis report recently released estimated that CNG and LNG trucks using spark ignition engines (SING) emit about the same amount of CO_2 -equivalent emissions, and these emissions are slightly higher than that of diesel engines.[808] The HPDI engines (DING) fueled by LNG are estimated to be the lowest emitting of the several scenarios analyzed by the study. Because the study did not discuss vehicle boil-off emissions, it is likely that the study either assumed that these emissions are zero or assumed the default vehicle boil-off emission estimates made by GREET. It is likely that the study assumed that the liquefaction plants are 90 percent efficient as this is the default assumption in GREET, which leads to lower GHG emissions by LNG trucks.

C. Projected Use of LNG and CNG

We reviewed several sources to estimate how much natural gas is currently being used and is projected to be used by heavy-duty trucks. Projections for this emerging technology range from 7 percent of new heavy-duty vehicle sales to over 40 percent by 2040. Large uncertainties exist even since the 2014 NAS First Report was written.[809] Among the range of projections we assessed, that produced by the Energy Information Administration (EIA) seemed the most credible for capturing recent trends, and for projecting future natural gas use by heavy-duty trucks. There are several factors that support this assessment.

First, in its 2014 Annual Energy Outlook, EIA estimates that natural gas fueled 0.4 percent of the energy use of heavy-duty trucks in 2014. This estimate is consistent with the fraction of the heavy-duty fleet which is fueled by natural gas as estimated by the industry.[810] Conversely, other studies referenced by the NAS report assume that current use is already about 2 percent (the DRIA contains more discussion about these other projections).

Second, the EIA projection is based on an economic analysis which considers the increased cost of manufacturing a natural gas truck over a diesel truck, the fuel savings for using natural gas instead of diesel fuel, and whether the payback time of the fuel savings against the increased truck cost would result in purchases of natural gas trucks. As part of this analysis, EIA assumes that lighter heavy-duty trucks would use CNG, which is a lower cost technology suited for the shorter driving distances for these trucks. The long haul trucks, however, require larger on-board stores of fuel to extend the driving range which is satisfied by storing the natural gas as a liquid. LNG has about 60 percent of the energy density of diesel fuel, compared to CNG which has only 25 percent of the energy density of diesel fuel. To satisfy the long driving range of the long haul trucks, EIA assumed that they would use LNG as a fuel. The assumptions used by EIA for conducting its economic analysis all seem reasonable.

Third, EIA is one of the several organizations in the world which collects fuel pricing data and projects future fuel prices using a sophisticated modeling platform. One of the most important assumptions in projecting the future use of natural gas in the transportation sector is the relative price of natural gas to the price of diesel fuel. In 2014, the natural gas price purchased by industrial users was about $6 per million BTU. The price of crude oil has been volatile during 2014 as the Brent crude oil price started at about $110 per barrel, but decreased to under $50 per barrel. From EIA's Web site, the average retail diesel fuel price in the first part of 2014 was about $3.80 cents per gallon. When comparing the natural gas spot market price on a diesel equivalent basis to the diesel fuel price, it appears that natural gas is priced about one quarter of the diesel fuel price. However, if used as compressed natural gas, the natural gas must be distributed through smaller distribution pipeline system that exists in cities, which increases the price of the natural gas. Then the natural gas must be compressed and stored at a retail outlet, and then dispensed to CNG trucks. The estimated retail price of CNG is $2.35 on a diesel gallon equivalent (DGE) basis, or about $1.45 DGE less than diesel fuel. LNG plants are assumed to be located close to large transmission pipelines away from cities, thus, it is sourced from lower cost natural gas. However, for producing LNG, the natural gas must be liquefied, shipped to retail outlets, stored and then dispensed to LNG trucks. These steps add substantially to the price of the LNG and the estimated retail price of LNG is $2.65 DGE, or $1.15 DGE less than diesel fuel.

In its 2014 AEO projections, EIA estimates that crude oil prices in the upcoming years will decline modestly until after 2020 when they start increasing until they reach $140/bbl in 2040. Natural gas prices are expected to only slightly increase over this period.

Fifth, the assumptions regarding payback used by EIA seemed reasonable. EIA projects that natural gas trucks begin to be purchased when the payback times are 4 years or less based on a survey conducted by the American Trucking Association. This is consistent with conversations the agencies have had with some fleet owners. Since EIA does not report the payback times as an output of its projections, it is useful to understand payback times. The 2014 NAS Phase 2 First Report cites the payback for the extra cost of natural gas trucks as 2 years, but other sources

[806] Low Carbon Fuel Standard Reconsideration: CA–GREET Model Update, California Air Resources Board, August 22, 2014.

[807] Per Anthy Alexiades of CARB: CARB is planning to propose a new draft lifecycle analysis for CNG and LNG trucks at an April 2015 public meeting. While the CNG lifecycle GHG emissions are expected to be about the same, the LNG lifecycle emissions are expected to be lower based on using a 90% efficiency for liquefaction plants instead of the 80% efficiency that CARB was using previously. Lifecycle emissions for both CNG and LNG trucks will be adjusted to be 10% higher if using a spark ignition engine to account for their lower thermal efficiency. These estimates are solely for hypothetical analyses. LCFS credits are awarded based on GHG emissions for each specific application.

[808] Jaffe, Amy Myers, Exploring the role of Natural Gas in U.S. Trucking, NextSTEPS Program, UC Davis Institute of Transportation Studies, February 18, 2015.

[809] B. Tita, Slow Going for Natural-Gas Powered Trucks; Wall Street Journal, 8/26/2014.

[810] NGV America estimates that there are 62,000 natural gas fueled heavy-duty trucks and buses operating in the U.S. out of a total of 12.3 million heavy-duty trucks and buses operating in the U.S., which equates to 0.5%.

report a longer return closer to 4 years.[811]

EPA assessed the time required for the lower fuel cost of CNG and LNG to payback the incremental truck cost of using LNG and CNG. The CNG tank plus fuel weighs on the order of four times as much as the diesel counterpart, and typically adds $40,000–$50,000 to the cost of a heavy-duty truck. In 2014, we estimated the payback time to be over 5 years when we assessed the payback at the higher crude oil prices at the beginning of the year. The payback rates would be even higher if we would have assessed the payback rates at the end of the year when the crude oil prices were much lower. However, for many fleets, even the payback rates at the higher crude oil prices would not be sufficiently attractive, and generally explains the low penetration of natural gas in the heavy-duty sector today. It appears that when the payoff time is longer than 4 years, few fleets are interested in purchasing natural gas trucks without subsidies to compensate for the higher purchase price of natural gas trucks. According to EIA, half the natural gas consumption by cars and trucks is in California, a state that subsidizes the purchase price of natural gas vehicles, and also subsidizes the cost of natural gas dispensing stations. The Low Carbon Fuel Standard in place in California also incentivizes natural gas use because natural gas is considered to cause less of an impact on the climate than petroleum-based gasoline and diesel fuel.[812] The majority of the other half of the NG fleet resides in states which subsidize the cost of using natural gas by motor vehicles.

Based on the EIA projections for crude oil and natural gas prices, the payoff time of LNG trucks is expected to remain long (more than 5 years) until sometime after 2020 when crude oil prices are projected to begin increasing. Thus, natural gas use by heavy-duty trucks is not projected by EIA to increase above 1 percent of the heavy-duty fuel demand until after 2025.

If the apparent payback time for CNG and LNG trucks use is favorable to fleet owners, fuel availability could still slow the transition to CNG and LNG. This is because CNG and LNG availability at service stations is currently 1 percent or less of the availability of gasoline and diesel fuel and therefore not available for most fleets. LNG availability is particularly challenging because in addition to an LNG service station, a LNG liquefaction plant would be needed as well.

To the extent that natural gas displaces diesel fuel and impacts truck greenhouse gas emissions, either positive or negative, there would be little impact on overall greenhouse gas emissions because of the low natural gas truck sales that are expected to occur over the next decade. The low natural gas use by the heavy-duty sector during the Phase 2 timeframe will give us time to learn more about both upstream and downstream methane emissions to gain a better understanding of the lifecycle impacts of natural gas use by heavy-duty trucks. It will allow us more time to consider the best additional steps to take to further reduce upstream and downstream methane emissions to improve the lifecycle impacts of natural gas use by heavy-duty trucks should the heavy duty truck fleet begin consuming natural gas in much larger quantities.

D. Natural Gas Emission Control Measures

As interest in the potential use of natural gas as a heavy-duty fuel has increased, industry has begun to investigate how to improve the overall emission performance of natural gas vehicles, especially with respect to reducing methane leaks. EPA is proposing two control measures which are discussed in Section XI. There are additional items discussed in Section XI. D. (2) on which we request comment. Included in this list are several control options.

(1) Proposed Control Measures

As is discussed earlier in this preamble in Sections II and XIII. EPA is proposing some control measures to reduce potential methane emissions from natural gas vehicles. These are summarized here. Note that since these controls are being proposed to address GHG emissions rather than fuel consumption, NHTSA is not proposing equivalent requirements.

(a) Proposed Closed Crankcase Requirement for NG Fueled Engines and Vehicles

EPA is proposing to require that all natural gas engines have closed crankcases, rather than continuing the provision that allows compression-ignition engines to separately measure and account for crankcase emissions that are vented to the atmosphere. This allowance has historically been in place to account for the technical limitations related to recirculating crankcase gases with high PM emissions back into the engine's air intake. Natural gas engines have inherently low PM emissions, so there is no technological limitation that would prevent manufacturers from closing the crankcase and recirculating all crankcase gases into the engine's air intake. The methane standard that was introduced in Phase 1 of this rule accounts for crankcase emissions, but when the system is sealed and emissions are routed to the engine intake, those emissions will be considered in determining the deterioration factor. See the Preamble Section II. D. for a description of the proposed closed crankcase requirement for natural gas fueled engines. This requirement would apply to the manufacturer responsible for criteria emission compliance: The vehicle manufacturer for complete pickups and vans, and the engine manufacturers for all other vehicles.

(b) Proposal To Require 5 Day Hold Time for LNG Vehicles

Boil-off emissions from LNG vehicles were not addressed in the Phase 1 rulemaking. As more testing has been done in this area since that time for this rising issue, as described in the Preamble Section XII, EPA is proposing to require manufacturers to follow current industry recommended practice, SAE J2343 for five day hold time to limit boil-off emissions from LNG vehicles. The specifications of this safety related standard has an effect which helps new LNG vehicles prevent boil-off. This SAE standard will only affect new LNG vehicles. It will not address aging vehicles as their insulating properties diminish such as loosing vacuum over time and may eventually result in much shorter hold times.[813]

EPA proposes to require the certificate holder for the chassis to also comply with the proposed requirements for LNG fuel systems, but to apply the delegated assembly and secondary manufacturer allowances for these requirements. We request comment on this approach generally, as well as on:

- The need for additional requirements for manufacturers not holding certificates, such as requiring that fuel system manufacturers participate in recalls for defects in their components.
- The appropriateness of requiring or allowing separate certification of fuel

[811] Early LNG Adopters Experience Mixed Results; Truck News, October 1, 2013.

[812] CARB currently estimates for the LCFS that CNG and LNG trucks reduce GHG-equivalent emissions by 32% and 17%, respectively, compared to gasoline and diesel fuel. In August 2014, CARB proposed reducing the GHG-equivalent benefit of CNG and LNG trucks to 22% and 3%, respectively, compared to gasoline and diesel fuel.

[813] The LNG storage tanks achieve some of their insulating properties due to a vacuum created between the two walls of the double-walled LNG storage tank.

systems (or similar provisions) where they are installed by manufacturers not holding the certificate for the chassis with respect to CO_2 and fuel consumption.

(2) Additional Natural Gas Topics for Comment

In this section we request comment on several additional areas related to potential regulatory requirements for natural gas fueled vehicles. See Chapter 13 of the Draft RIA for additional details on these topics.

(a) Request for Comment on Changing Global Warming Potential Values in the Credit Program for CH_4 (See Also Preamble Section II.(D)(5)(b))

The phase 1 heavy-duty vehicle rulemaking establishing greenhouse gas emission standards included a compliance alternative allowing heavy-duty manufacturers and conversion companies to comply with the respective methane or nitrous oxide standards by means of over-complying with CO_2 standards (40 CFR 85.525). The heavy-duty rules allow averaging only between vehicles or engines of the same designated type (referred to as an ''averaging set'' in the rules). Specifically, the phase 1 heavy-duty rulemaking added a CO_2 credits program which allowed heavy-duty manufacturers to average and bank pollutant emissions to comply with the methane and nitrous oxide requirements after adjusting the CO_2 emission credits (generated from the same averaging set) based on the relative GHG equivalents. To establish the GHG equivalents used by the CO_2 credits program, the phase 1 heavy-duty vehicle rulemaking incorporated the IPCC Fourth Assessment Report global warming potential (GWP) values of 25 for CH_4 and 298 for N_2O, which are assessed over a 100 year lifetime.

Since the Phase 1 rule was finalized, a new IPCC report has been released (the Fifth Assessment Report), with new GWP estimates. This is prompting us to look again at the relative CO_2 equivalency of methane and to seek comment on whether the methane GWP used to establish the GHG equivalency value for the CO_2 Credit program should be updated to those established by IPCC in its Fifth Assessment Report. The Fifth Assessment Report provides four 100 year GWPs for methane ranging from 28 to 36. Therefore, we not only request comment on whether to update the GWP for methane to that of the Fifth Assessment Report, but also on which value to use from this report.

(b) Request for Comment on Appropriate Deterioration Factors for NG Tailpipe Emissions

The current assigned deterioration factors for CO_2, N_2O, and CH_4 are based on diesel technology. While EPA still believes this is likely appropriate, we would welcome data to support this policy or other comments on how appropriate these factors are applied to NG engines and vehicles.

(c) Request for Comment on LNG Vehicle Boil-Off Warning System

A simple means to help limit boil-off emissions would be to require that natural gas truck drivers be alerted to expected near-future boil-off events. Such an alert could be in the form of a warning light and associated audible alarm that would indicate that the LNG storage tank is approaching a pressure which would require the tank to vent. Knowing this, the truck driver could take action to prevent such a release, such as starting to drive the vehicle, which likely would reduce the pressure in the tank, or connecting the vent line to either a LNG storage tank or natural gas pipeline for venting. EPA requests comment on the feasibility and appropriateness of a regulatory requirement that LNG fueled vehicles include a warning system that would notify the driver of a pending boil-off event as one means reduce the frequency of such events and thus limit the release of methane.

(d) Request for Comment on Extending the 5 Day Hold Time for LNG Vehicles

The specifications of the proposed 5 Day Hold Time SAE 2343 safety related standard will only affect new LNG vehicles to prevent boil-off initially and does not address aging vehicles as their insulating properties diminish such as loosing vacuum over time that may eventually result in much shorter hold times. LNG tank manufacturers are further developing their technologies for improvement of hold times and reducing boil-off from LNG storage tanks on trucks. These improvements can be incorporated by requiring longer hold times. EPA is soliciting comment on the ability of these emerging technologies to address an extension of 5 days to a longer period of time such as 10 days and the ability to achieve the hold times for the duration of the vehicle's useful life.

(e) Capturing and/or Converting Methane Refueling or Boil-Off Emissions

We would like input on how effective and feasible the following potential emissions control technologies are for achieving longer hold times in LNG vehicles.

A methane canister using adsorbents such as ANG (adsorbed natural gas) could be added to capture the methane which otherwise would be released to the environment during a refueling or boil-off event. Once captured, steps could be taken to route the methane to the engine intake once the vehicle is operating again, or to take steps to converting the methane to less GHG-potent CO_2.

Instead of discharging methane to the environment, the methane potentially could be burned to CO_2 using a burner. Another potential option would be to convert the methane capture in a canister to CO_2 over a catalyst.

(f) Request for Comment on Reducing Refueling Emissions

When refueling a natural gas vehicle, methane is vented to the atmosphere. As of Tier 3 it is required by EPA to use the ANSI–NGV1–206 standard practice to meet the evaporative emissions refueling requirement. Small puffs of up to 200 cc/hr (which equates to 72 grams of methane per hour) of leakage are allowed with these tests. Often there is a vent line which carries these puffs away from the nozzle interface for safety reasons but is then vented to the atmosphere. EPA is requesting comment on ways to eliminate or reduce these losses. If there must be allowances for losses, then how can this methane gas be captured during refueling using systems that route methane emissions back to the fuel storage tank, whether it is a CNG tank, a CNG pipeline or re-liquefying system for LNG. For LNG, in addition to the boil-off issue is the recurrence of manual venting at refueling by truck operators. Under high pressure circumstances, such as when the vehicle has been sitting for some time period in warmer temperatures, it is necessary to decrease the pressure in the fuel tank before new fuel can enter the tank. The recommended practice is to transfer the extra vaporized fuel to the gas station or natural gas pipeline, but this can take extra time. In some areas it has turned into common practice to just vent to the atmosphere to keep the down time at the refueling station to a minimum. In other areas there is an incentive to reroute the gas into the station storage tank or natural gas pipeline with credit towards the fuel purchase. EPA is requesting comment on approaches to reduce refueling emissions for LNG vehicles.

(g) On-Board Monitoring Requirements for Boil-Off Events and Venting at Refueling

Onboard diagnostics for engines used in vehicle applications greater than 14,000 lbs GVWR are already required to detect and provide a warning for when methane leaks occur due to wear of connections and components of the CNG or LNG fuel system (74 FR 8310, February 24, 2009). We are requesting comments on requiring on-board monitoring to track boil-off events as well as whether the excess vapors were properly vented to the station storage tanks or NG pipeline, or whether the gaseous methane emissions were vented to atmosphere during refueling events. Each boil off event has the potential to release on the order of 5,300–15,800 grams of CH_4 which translates to 132K–400K grams CO_2 equivalent with a GWP of 25 for 100 years.

(h) Separate Standards for Natural Gas Vehicles

As described above, the climate impact of leaks and other methane emissions that occur upstream of the vehicle can potentially be large enough to more than offset the CO_2 benefit of natural gas vehicles as measured at the vehicle tailpipe. EPA is considering separate action to control these upstream emissions. Nevertheless, we have some concern that the impact of upstream emissions for natural gas much higher than for gasoline or diesel fuel because of the high Global Warming Potential (GWP) for methane that makes even small leaks of natural gas of concern. In this way, natural gas is very different than other alternative fuels.

While we are not proposing any provisions to address this, we may consider adopting such provisions in the final rule and are asking for comments on this topic. Would it be appropriate to adjust the tailpipe GHG emission standard for natural gas vehicles by a factor to reflect the life cycle emissions of natural gas vehicles relative to diesel vehicles? For example, if we were to determine that the life-cycle climate impacts of natural gas vehicles were 150 percent of the tailpipe GHG emissions, while the life-cycle climate impacts of diesel vehicles were 135 percent of the tailpipe GHG emissions, we could approximate the relative climate impacts by setting the natural gas tailpipe emission standard 10 percent lower than the diesel tailpipe standard. We recognize that there is significant uncertainty is assessing these relative climate impacts, and that they could change as new production methods and/or regulations go into effect. Thus commenters supporting making such an adjustment are encouraged to address this uncertainty. Commenters are also encouraged to address how such an adjustment for GHG emissions would impact the closely coordinated EPA and NHTSA heavy-duty Phase 2 program including how a potential adjustment for upstream methane emissions for natural gas fueled vehicles would impact the coordination of EPA GHG regulations with the NHTSA fuel consumption regulations.

E. Dimethyl Ether

Although NAS (2014) focused its recommendations on natural gas, it also discussed dimethyl ether (DME), which is a potential heavy-duty truck fuel sourced from natural gas. Dimethyl ether has a high cetane number (more than 55), although its energy density is about 60 percent of that of diesel fuel. Dimethyl ether is a volatile fuel, like liquid petroleum gas, that can be stored as a liquid at normal ambient temperatures under moderate pressure. Typical DME fuel tanks would be designed to prevent any significant evaporative emissions.

A DME fueled truck is only modestly more expensive than a diesel fuel truck. The fuel tank is more expensive than a diesel fuel tank, but much less expensive than an LNG tank since it does not need to be heavily insulated. The engine modifications to enable using DME are also modest. Because DME does not have carbon-carbon bonds that form particulate matter particles during combustion, the particulate filter, which is standard equipment on new diesel trucks, can be eliminated. This offsets some of the engine and fuel tank costs.

Although DME is sourced from cheap natural gas, the conversion of natural gas to DME and moving the fuel to retail outlets greatly increases the cost of the fuel. DME is more expensive than LNG, but still lower in cost than diesel fuel based on the fuel prices in early 2014. DME is estimated to cost $3.50/DGE, or $0.30 DGE less than diesel fuel.

Because there is very little DME use in the U.S. (there is only a very small fleet of trucks in California), we did not conduct a lifecycle assessment of DME, but note here a few aspects of a lifecycle analysis for DME. First, since DME is sourced from natural gas, the upstream methane emissions from the natural gas industry would still be allocated to DME. Second, there are not venting issues associated with DME as with LNG or CNG refueling. Third, DME itself has a much lower global warming potential than methane. DME's global warming potential is estimated to be 0.3 when assessed over a 100 year lifetime, which is about 1 percent of methane's GWP.

XII. Agencies' Response to Recommendations From the National Academy of Sciences

A. Overview

As part of the Phase 1 standards, the agencies were informed by a report generated by the National Academy of Sciences (NAS), as required by Congress in EISA.[814] In addition to that initial report, Section 107 of EISA requires that the report be updated in five year intervals through 2025.[815] On September 24, 2016, NAS will release its updated report under Congress' quinquennial update requirement. However, because the Phase 2 rules will be completed prior to the issuance of the first update, NAS issued an interim report in the form of a First Report (NAS HD Phase 2 First Report) published on April 3, 2014.[816] The agencies have consulted the report and considered its findings in creating this proposal. The National Research Council formed the Committee on Technologies and Approaches for Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles, Phase Two (the Committee or NAS Committee) in order to prepare the NAS HD Phase 2 First Report. In its Phase 2 First Report, the Committee seeks to advise NHTSA on the HD Phase 2 rules while meeting the agencies' objectives of:

- Reducing in-use emissions of carbon dioxide from medium- and heavy-duty vehicles
- Reducing in-use emissions of other GHGs from medium- and heavy-duty vehicles
- Improving the in-use efficiency of fuel use in medium- and heavy-duty vehicles—by driving innovation, advancement, adoption, and in-use balance of technology through regulation

[814] Energy Independence and Security Act of 2007, Public Law 110–140, section 108(a).

[815] EISA further states that the NAS must submit the report to DOT, the Senate Committee on Commerce, Science, and Transportation, and the House Committee on Energy and Commerce not later than one year after the date on which the Secretary executed the agreement with the NAS.

[816] Transportation Research Board 2014. ''Reducing the Fuel Consumption and Greenhouse Gas Emissions of Medium- and Heavy-Duty Vehicles, Phase Two.'' (''Phase 2 First Report'') Washington, DC, The National Academies Press. Cooperative Agreement DTNH22–12–00389. Available electronically from the National Academy Press Web site at *http://www.nap.edu/catalog.php?record_id=12845* (last accessed December 2, 2014).

In providing the First Report recommendations, the committee acknowledged the following constraints:

- Holding life-cycle cost of technology change or technology addition to an acceptable level
- Holding capital cost of acquiring required new technology to an acceptable level
- Acknowledging the importance of employing a balance of energy resources that offers national security
- Avoiding near-term, precipitous regulatory changes that are disruptive to commercial planning
- Ensuring that the vehicles offered for sale remain suited to their intended purposes and meet user requirements
- Ensuring that the process used to demonstrate compliance is accurate, efficient, and not excessively burdensome
- Not eroding control of criteria pollutants or unregulated species that may have health effects

Although the Phase 2 First Report was developed and written in terms of reducing fuel consumption, its findings and recommendations in general apply equally to a program that reduces GHG emissions, given the close relationship between the two.

B. Major Findings and Recommendations of the NAS Phase 2 First Report

While the agencies have addressed many NAS recommendations as they pertain to individual areas of the Phase 2 standards, this section consolidates all of the recommendations from the NAS HD Phase 2 First Report and discusses the extent to which the agencies' proposed program is consistent with them. The NAS HD Phase 2 First Report contains more than 40 recommendations to the agencies. All of the Committee's recommendations have been considered, and many of them have been incorporated in the Phase 2 standards. In some instances, the agencies have chosen a different course from the one charted by the NAS Committee's recommendations.

Instead of discussing the NAS report findings and recommendations in the order presented in the Phase 2 First Report itself, this section divides the NAS findings and recommendations in three categories: Findings and recommendations with which (1) the Phase 2 standards are consistent; (2) the Phase 2 Standards are significantly inconsistent; and (3) the Phase 2 standards are less-significantly inconsistent.

(1) NAS Findings and Recommendations With Which Phase 2 Standards Are Consistent

(a) How should the agencies address standards for trailers in the phase 2 rulemaking?

Given the exclusion of trailers from the Phase 1 standards, the Committee focused on a wide array of opportunities by which the agencies could reduce fuel consumption and GHG emissions. The Committee evaluated potential fuel consumption- and GHG-reducing technologies that can be incorporated on a trailer as well as components of a trailer, such as tire-related technologies.

The Committee found that many opportunities exist for trailers to reduce fuel consumption and GHG emissions of the pulling tractor. More specifically, the Committee evaluated trailer aerodynamics, tire rolling resistance, and tire pressure monitoring systems.

Despite the fuel consumption- and GHG-reducing possibilities of the trailer technologies the Committee evaluated, a survey it conducted found that only 40 percent of new van trailers came equipped with fuel-saving aerodynamic devices.[817] Further, the Committee found that most trailer devices on average, within one year, saved enough in fuel cost to pay for the added cost of the device. The Committee observed that when a trailer is not owned by the tractor operator, there is no incentive for the trailer owner to purchase fuel-saving devices. Moreover, the Committee stated that in absence of regulation, many trailer owners do not choose to employ fuel saving devices.

The Committee recommended that NHTSA, in coordination with EPA, adopt a regulation requiring that all 53 foot and longer dry van and refrigerated van trailers meet performance standards that reduce fuel consumption and GHG emissions.[818] It also recommended that NHTSA assess the benefit of using GEM to address all tractors in combination with trailers.[819] The Committee also recommended the agencies collect real-world data on fleet use of aerodynamic trailers to help inform standards.[820]

As discussed in more detail in Section IV, the agencies are proposing to adopt Phase 2 standards for all new dry van and refrigerated van trailers, including both those above and below 53 feet in length. The agencies have carefully evaluated the lead time for implementation of this potential program to take into consideration factors such as existing market conditions and the fact that a regulation of new trailers will include companies that have not previously been regulated for fuel consumption and GHG emissions. To the degree that it is available, the agencies are gathering data on real world fleet use of aerodynamic devices, both to understand the overall context of the rules and for specific analytical purposes such as the appropriate role of aerodynamic devices on the reference trailer used for tractor aerodynamic assessment. The agencies have also assessed the benefit of using GEM to address all tractors in combination with trailers and are proposing that, for the long-term program, GEM be used to demonstrate compliance with both the tractor and the trailer requirements of the Phase 2 program.

In addition to the Committee's recommendation that NHTSA and EPA regulate 53 foot and longer box trailers, the Committee recommended that NHTSA and EPA assess the practicability and cost-effectiveness of including pups, flat-beds, and container chassis.[821] The Committee found that pups, flat-beds, and container chassis demonstrated fuel savings, however, factors such as average speed, mileage, and practical concerns such as access to equipment underneath the trailer needed to be assessed.[822]

The agencies have evaluated whether it would be practical and cost effective to include pups (in tandem or separately), other box trailers of lengths between that of pups and standard 53-foot trailers, flatbeds, container chassis (with and without containers attached), tankers, and other trailer types in the Phase 2 regulation. As a result of this analysis, the agencies are proposing to include pups as well as box vans between 28 feet and 53 feet long in Phase 2. With regard to other types of trailers, such as tankers, flatbeds, and container chassis, the agencies have evaluated issues such as trailer plumbing, flat bed ground clearance, chassis stacking, trailer duty cycles, cost of technologies, and other issues. The agencies are proposing that these and other non-box trailers be included in Phase 2 requirements. However the agencies are assuming compliance with the Phase 2 program for these non-box trailers will be limited to tire technologies.

Finally, the Committee examined the use of GEM for tractor and trailer compliance. It asserted that tractors and trailers are fundamentally inseparable

[817] *See* Note [3] at 78.

[818] *Id.*, Recommendation 6.1.

[819] *Id.*, Recommendation 3.12.

[820] *Id.*, Recommendation 6.1.

[821] *Id.*, 6.2.

[822] *Id.* at 83.

when addressing aerodynamic drag and design. As applied to GEM simulation, the Committee opined that considering tractors and trailers separately for simulation purposes might prove counterproductive, because components on a tractor and trailer might compromise aerodynamic optimization. The Committee recommended that NHTSA assess the benefit of using GEM to address all tractors in combination with trailers.[823]

As stated above, the agencies have assessed the benefit of using GEM to address all tractors in combination with trailers and are proposing to use GEM for both tractors and trailers for the Phase 2 program for tractors and trailers, similar to what was done in Phase 1. In Phase 1, which did not regulate trailers, this meant simulating each tractor being certified as being used in combination with a standard reference trailer. For these rules, we are proposing to simulate each trailer being certified as being used in combination with a standard reference tractor.

(b) Have the agencies revisited dieselization of Class 2b through 7 vehicles?

The Committee reiterated a recommendation from its Phase 1 report regarding the study of dieselization of Class 2b through 7 vehicles.[824] The Committee stated that diesel engines present an opportunity for incremental fuel efficiency gains. The NAS Committee recommended that NHTSA conduct a study of Class 2b to 7 vehicles to consider the incremental fuel consumption reduction of diesels, the price of diesel versus gasoline, and the diesel advantage in durability.[825]

As part of the Phase 2 proposed rule analysis, the agencies evaluated many potential fuel efficiency and greenhouse gas reduction (FE/GHG) technologies for both gasoline and diesel fueled vehicles. As will be discussed in detail in later responses, NHTSA sponsored research at Southwest Research Institute (SwRI) included simulations of baseline and projected Phase 2 FE/GHG technologies for Class 2b through 7 vehicles over a range of appropriate duty cycles.[826] A HD pickup truck (Class 2b), the Dodge Ram 2500, was modeled using a 385-hp 6.7-liter diesel engine as the baseline. The vehicle's baseline performance and the effectiveness of FE/GHG technologies with the diesel engine were compared over identical duty cycles to two gasoline engines, a 6.2-liter naturally aspirated gasoline V–8 and 3.5-liter turbocharged direct injection V–6, with their corresponding engine technologies. Similarly, two medium-duty trucks (Class 6), the Ford F–650 and Kenworth T–270, were modeled using a 300-hp 6.7-liter diesel engine as the baseline and compared to the two aforementioned medium-duty V–8 and V–6 gasoline engines.

Many of the diesel engine technologies evaluated in supporting Phase 2 research are currently available, proven, and on the path to increased penetration across the fleet. Other technologies are still in development and looking for the opportunity to enter the mainstream production lifecycle. For the latter, the agencies believe, as informed through the proposed rule development research, that costs, reliability, durability, and clear user benefits are important when determining potential future technology applications to achieve attainable standards resulting in real-world reductions. As identified in the proposal, the agencies considered these important factors when developing the proposed standards and, included in the analysis, are technologies that recognize the value of the current and future fleet dieselization.

However, the agencies recognize that there are valid reasons for why medium and heavy-duty vehicle purchasers sometimes choose gasoline engines over diesels. Gasoline engines are generally lighter and less expensive than diesels, although they typically do not last as long in heavy-service. For applications in which the vehicle is not expected to travel many miles each year, gasoline engines may be the best choice. On the other hand, for applications in which the vehicle is expected to travel many miles each year, diesels can be a more appropriate choice.

(c) What kind of analyses are the agencies doing on upstream emissions related to natural gas?

The NAS Committee discussed the potential natural gas presents for reducing fuel consumption and GHG emissions in medium- and heavy-duty vehicles. The Committee stated that while tailpipe emissions are often the most observable instance of fuel consumption and tailpipe emissions, the fuel production, distribution, and processing components of obtaining natural gas for use in vehicles also factors into any calculation of overall benefits derived from natural gas vehicles.[827] The Committee recommended that NHTSA, in coordination with EPA, begin to consider the well-to-wheel, life-cycle energy consumption and greenhouse emissions associated with different vehicle and energy technologies to ensure future rulemakings best accomplish their overall goals.[828]

The agencies recognize that understanding the life-cycle implications of vehicle and energy technologies is important to ensure that the rulemaking accomplishes its overall goals. In the Draft and Final Environmental Impact Statement (EIS) prepared for the 2017 and Later Model Year Light-Duty Vehicle GHG Emissions and CAFE Standards rulemaking, NHTSA introduced a literature synthesis of life-cycle environmental impacts of certain vehicle materials and technologies. Consistent with that approach, in the Draft EIS for Phase 2, NHTSA has again provided a literature synthesis of life-cycle environmental impacts, focusing on the unique vehicle technologies for the HD sector and incorporating by reference the literature synthesis prepared for the MY 2017 and beyond CAFE Final EIS. The Draft EIS also uses the GREET fuel-cycle model to assess upstream emissions from extraction, refining, and transportation of medium- and heavy-duty vehicle fuels. This information in the Draft EIS informs both the agency and the public about the potential life-cycle implications of the various technologies under consideration in this rulemaking. NHTSA invites comments on the Draft EIS and its literature synthesis of life-cycle environmental impacts.

EPA has also evaluated the lifecycle impact of heavy-duty trucks being fueled with natural gas in comparison to other heavy-duty trucks. This analysis is presented in Section XI along with a discussion of projections for future use of natural gas by heavy-duty trucks.

(d) How have the agencies evaluated aerodynamic testing methods for the Phase 2 program?

With regard to aerodynamic devices, the NAS Committee reviewed aerodynamic test procedures related to evaluating aerodynamic effectiveness. The Committee found that industry testing procedures can vary widely because of the precision of the standards themselves.[829] Further, the Committee found that fidelity of test results from coastdown procedures versus results from a powered on-track test is not known. The Committee recommended that NHTSA and EPA evaluate the

[823] *Id.* at 38, Recommendation 3.12.

[824] *Id.* at 14–15.

[825] *Id.*

[826] *See* the 2015 NHTSA Technology Study, Note 289 above.

[827] *Id.* at 19–20.

[828] *Id.* at 20, Recommendation 1.10.

[829] *Id.* at 83–84.

relative fidelities of the coast-down procedure and candidate powered procedures to define and optimum prescribed full-vehicle test procedure and process and validate the improved procedure against real world vehicle testing.[830] It also recommended that NHTSA and EPA assess whether adding yaw loads provides significantly increased value to the Cd result. The Committee recommended providing updated test data to manufacturers to increase consumer confidence in the accuracy (and real-world applicability) of the testing measures as related to aerodynamic devices.[831] [832]

The agencies have undertaken a coordinated research program to inform the Phase 2 certification test procedure for aerodynamic drag and tire rolling resistance. The U.S. EPA and its contractors have evaluated coastdown, constant speed, CFD, and scale wind tunnel testing for tractors and trailers. The goals of this research effort were to: Assess variability between test methods; assess how yaw impacts aerodynamic performance; evaluate correlation of different test methods one to another; assess the impact of different tractor/trailer design attributes on the test results; examine how differences between manufacturers' products impact aerodynamics; and measure Cd improvements from a variety of aerodynamic devices in combination and alone. NHTSA and its contractors conducted simulation modeling to: Evaluate aerodynamic drag and tire rolling resistance improvements in combination with other vehicle and engine technologies, and determine the impact of different duty cycles on aerodynamic drag performance. Finally, EPA has conducted an analysis to determine whether or not adding yaw adjustments to the certification process improves the Cd result. As a result, the agencies are proposing to add yaw adjustments to the certification process for tractors. The agencies are disseminating the results of these test programs and conclusions at association meetings and public meetings such as SAE COMVEC.

Through the research programs described above, the agencies have evaluated aerodynamic data that better reflects real-world experience. And, to the extent available, the agencies have collected aerodynamic performance data that reflect real-world experience. This information has informed the Phase 2 proposal. For example, in addition to the agencies are proposing to account for yaw in the aerodynamic assessment for Cd, we are also proposing changes to vehicle speeds used in the aerodynamic reference test procedure to facilitate improved estimation of Cd.

(e) What kind of new modeling research has been conducted to inform Phase 2?

With a wide range of potential fuel consumption- and GHG emissions reducing technologies, the NAS Committee found that it is proper to assess the various combinations of technologies in real-world testing and in modeling. The Committee recommended that NHTSA conduct detailed simulation modeling in addition to physical testing.[833]

In September 2012, NHTSA contracted with the Southwest Research Institute (SwRI) to conduct research in support of the next phase of Federal fuel efficiency (FE) and GHG standards.[834] Tasks included determining the baseline fuel efficiency and emissions levels and technologies of current model year commercial medium- and heavy-duty on-highway vehicles and work trucks, as well as projections of Phase 2 fuel efficiency and emission reduction technologies for diesel and gasoline powered vehicles. The scope encompassed technologies for chassis and final-stage manufacturer vehicles and trailers, maintenance cost, material application, future design, capital investment, retail cost/payback and any other applicable advanced technologies. Estimates of the costs, fuel savings effectiveness, availability, and applicability of technologies were done for each individual vehicle class category (*e.g.,* segment).

Selection of FE/GHG technologies, engines, vehicles, drive-cycles, etc. for the simulation modeling at SwRI was done in coordination with EPA, which had complimentary HD research programs involving vehicle road testing and engine dynamometer testing that informed the simulation efforts. The SwRI analysis relied on a technology list that was developed from recent NAS HD vehicle fuel consumption reports as well as an extensive literature review. Four base engines and four vehicles spanning the class 2b to class 8 vehicle segments were selected for simulation. Experimental data was available from other projects for all of the vehicles and engines simulated, and full use of experimental data was made to calibrate the models before additional technologies were evaluated.

SwRI used a vehicle simulation tool developed in-house to model vehicle performance over a range of drive cycles. The commercial software GT–POWER (Gamma Technologies, Inc.) was used to model engine performance, fuel consumption, and CO_2 emissions over the full speed-load range. Results of the agency-sponsored simulation modeling at SwRI will be issued in peer-reviewed research reports.

(f) How has GEM been modified by EPA?

In its report, the NAS Committee focused many of its recommendations on EPA's GEM. The Committee concentrated on what features could be incorporated into GEM in order to improve the model's ability to provide outputs representative of real-world use.

More specifically, the Committee found that GEM output was unaffected by the actual use of a smaller or larger engine in the same subcategory because the engine map used by GEM is predefined.[835] The NAS Committee recommended that the agencies should assess whether a single steady-state speed-torque map is sufficient for GEM accuracy in engine efficiency prediction.[836] EPA has evaluated this question and is modifying GEM to allow for different maps as an input.

Additionally, the Committee emphasized that a certification test must be highly accurate and repeatable. It stated that the need to account for the close interaction of the engine with other components, including the aftertreatment subsystem and transmission.[837] NAS recommended that the agencies allow powertrain testing for certification.[838] As described in Section II, the agencies are doing so in conjunction with GEM. See the proposed provisions in 40 CFR 1037.550, which further discusses powertrain testing and certification.

More generally, the NAS Committee recommended revising GEM to reflect the benefit of integrating an engines, aftertreatment, and transmissions and to cover as large a fraction of over-the-road tractor operation as possible without becoming overly cumbersome.[839] As described in Section II and in Chapter 4 of the draft RIA, the agencies believe the proposed revisions to GEM reflect this.

(g) What have the agencies done to validate GEM testing?

The NAS Committee expressed concern over GEM's ability to translate

[830] *Id.* at 84, Recommendation 6.3.

[831] *Id.* at 36, Recommendation 3.5.

[832] *Id.* at 84, Recommendation 6.3.

[833] *Id.* at 24, Recommendation 2.1.

[834] *Id.*

[835] *Id.* at 37.

[836] *Id.,* Recommendation 3.8.

[837] *Id.* at 14.

[838] *Id,* Recommendation 1.6.

[839] *Id.* at 37, Recommendations 3.10, 3.11.

to real world reductions in fuel consumption and GHG emissions. In particular, the Committee found that GEM's current certification procedures have limited unbound variables that can be user-specified and do not allow for synergy between components.[840] Moreover, the NAS Committee found that GEM does not allow for the operation of components in the most efficient way or efficiency that could be gained by the operation of a component at a higher relative load, concluding that vehicle designs that are optimized for the conditions of the simulation might not be optimized in real world operation.[841] The Committee recommended that NHTSA conduct a real world evaluation to validate GEM inputs with the fuel consumption outputs.[842] Additionally, it recommended that EPA and NHTSA should assess whether a steady-state torque map is sufficient for GEM accuracy in engine efficiency prediction.[843]

Recently, EPA and NHTSA sponsored a technical workshop at the Southwest Research Institute (SwRI). At this workshop, SwRI presented a multi-year research effort sponsored by EPA to validate GEM. The development version of GEM incorporates several engine, transmission, driveline, and vehicle technologies being considered to meet FE and GHG standards for MD/HD vehicles. GEM (including the steady-state fuel map approach) was validated by the agencies against over 130 test cases (multiple runs) of different size vehicles. See Section II of this notice and Chapter 4 of the draft RIA for further information about this validation work.

(h) Has NHTSA considered non-vehicular strategies to reduce fuel consumption?

In examining the broader picture of reducing fuel consumption, the NAS Committee found that there are opportunities to reduce fuel consumption in ways that that exceed NHTSA's statutory authority.[844] The Committee recommended that NHTSA work with and encourage EPA, DOE, and FHWA to reduce fuel consumption and GHG emissions by exploring non-vehicle approaches.[845]

NHTSA is jointly releasing this rulemaking with EPA, and has involved EPA as a co-drafter throughout the development of these rules. NHTSA has also worked with DOE, and has been in touch with FHWA about medium- and heavy duty fuel efficiency. While the majority of NHTSA's work with these agencies has been vehicle-related, NHTSA supports research and development on nonvehicle methods to reduce fuel consumption.

(2) NAS Findings and Recommendations With Which the Phase 2 Standards Are Significantly Inconsistent and Why the Agencies Chose a Different Course

(a) Should the agencies propose separate standards for natural gas vehicles?

The NAS Committee found that natural gas is a viable option to reduce fuel consumption and can also contribute to a reduction in GHG emissions, ''unless additional findings of methane leakage alter this vision.'' [846] It noted that natural gas engines are well-developed and are ready for use for medium- and heavy-duty vehicles, including Class 8 trucks. The Committee stated that while the load-specific CO_2 emissions from natural gas engines are less than a comparable diesel engine, that benefit is partially negated by lower engine efficiency and methane emissions.[847] The NAS Committee recommended that NHTSA and EPA develop a separate standard for natural gas vehicles, similar to that in diesel- and gasoline-fueled engines.[848] We interpret this to mean standards that require natural gas-fueled engines to achieve similar thermal efficiency to diesel- and gasoline-fueled engines; in other words more stringent standards than would apply under a continuation of the Phase 1 approach. Further, the Committee recommended the agencies do this without disrupting commercial transportation business models, though the Committee did not provide specific recommendations for how to achieve this goal.[849] It recommended that GEM certification tools need to include natural gas engine maps to accurately quantify the emissions and fuel economy of natural gas vehicles. The Committee also requested that EPA and NHTSA assemble a best estimate of well-to-tank GHG emissions to be used for developing future rulemakings.[850]

The agencies closely evaluated the recommendation for NHTSA and EPA to develop a separate natural gas standard for HD vehicles. The agencies are not proposing a separate standard for natural gas engines or for natural gas powered vehicles for the Phase 2 program primarily, because the current market share is still at or below one percent of the total heavy-duty fleet and we do not project a significant increase in natural gas use during the Phase 2 timeframe. Given its current status, we do not want to inhibit the adoption of this potentially promising alternative fuel through more stringent standards. Other reasons to hold back on potentially establishing separate natural gas fuel standards at this time include the fact that there is uncertainty in the quantification of methane emissions, both upstream emissions as well as potential leakage on a vehicle, particularly the LNG vehicle boil-off emissions, which makes it very difficult to perform a rigorous analysis regarding the potential impacts of a separate natural gas standard; the industry itself is in the process of developing its technology and as it matures there is potential for self-correction to address methane leaks in recognition of environmental concerns that might affect its status as a potential green alternative fuel.

With regard to well-to-tank or upstream emissions, the medium- and heavy-duty fuel efficiency program focuses on the tailpipe emissions of these vehicles for multiple reasons, including test measurement capabilities and the use of simulated output tools calibrated to test lab measurements. The agencies continue to evaluate the potential impacts and the benefits of a holistic approach for incorporating well-to-tank emissions into future rulemakings.

As data comes available a better estimate can be made on the emissions impact from any potential regulations. The agencies will closely monitor developments in natural gas adoption over the course of the rulemaking timeframe and determine if additional action may be necessary to prevent methane emissions increases. See Section XI of this preamble for additional discussion regarding the treatment of natural gas fuel, engines and vehicles in this proposal, as well as for a detailed discussion of lifecycle emissions.

(b) How are the agencies handling uniformity and accuracy regarding tire rolling resistance characteristics?

The NAS Committee expressed concern about the process by which rolling resistance values are established.[851] Specifically, the Committee noted that the process for

[840] *Id.* at 11.

[841] *Id.*

[842] *Id.,* Recommendation 1.2.

[843] *Id.* at 37, Recommendation 3.8.

[844] *Id.* at 15.

[845] *Id.,* Recommendation 1.9.

[846] *Id.* at 65.

[847] *Id.*

[848] *Id.* at 65, Recommendation 5.2.

[849] *Id.* at 65, Recommendation 5.3.

[850] *Id.* at 65, Recommendation 5.1.

[851] *Id.* at 35–36.

determining tire rolling resistance is new and variability is not as well known. The Committee recommended that the agencies implement a mechanism for obtaining accurate tire rolling resistance factors, including establishing a tire alignment laboratory.[852 853] Additionally, the Committee recommended that this data be available in the through the Uniform Tire Quality Grading system.[854]

In Phase 1, the agencies received comments from stakeholders highlighting a need to develop a reference lab and alignment tires for the HD sector. The agencies noted the lab-to-lab comparison conducted in the Phase 1 EPA tire test program. The agencies reviewed the rolling resistance data from the tires that were tested at both the STL and Smithers laboratories to assess inter-laboratory and test machine variability. The agencies conducted statistical analysis of the data to gain better understanding of lab-to-lab correlation and developed an adjustment factor for data measured at each of the test labs. Based on these results, the agencies believe the lab-to-lab variation for the STL and Smithers laboratories would have very small effect on measured rolling resistance values. Based on the test data, the agencies judge that it is reasonable to continue the HD Phase 2 program with current levels of variability, and consider the use of either Smithers or STL laboratories to be acceptable for determining the tire rolling resistance value in Phase 2. Note that the agencies have not made similar findings for other laboratories. However, we welcome comment on the need to establish a reference machine for the HD sector and interest from tire testing facilities to commit to developing a reference machine.

In the final rule for the Phase 1 program, the agencies stated that compliance values submitted to the agencies should be derived using the ISO 28580 test method for drive tires and steer tires planned for fitment to the vehicle being certified.[855] The agencies believe that following a defined, standardized test procedure will provide levels of consistency in submitted compliance values. The agencies conducted substantive testing to develop the final tire Crr standards in the Phase 1 rule at two different testing laboratories for comparison to test for variability. The agencies concluded that although laboratory-to-laboratory and test machine-to-test machine measurement variability exists, the level observed is not excessive relative to the distribution of absolute measured Crr performance values and relative to the proposed standards. Based on this, the agencies concluded that the test protocol and the proposed standards are reasonable for this program.

The agencies are considering publishing the tire Crr levels from fuel efficiency and GHG emission program compliance data. Because compliance data are submitted by vehicle manufacturers rather than directly from the tire manufacturers or agency directed testing they could vary for a given tire model among vehicle manufacturer submissions, or lag when tires are redesigned. Based on considerations such as this, the agencies are not proposing to establish a public database for heavy-duty vehicle tire rolling resistance information at this time.

(c) Have the agencies considered industry standards for medium- and heavy-duty Tire Pressure Systems (TPS)?

The NAS Committee found that tire pressure monitoring systems and automatic tire inflation systems are being adopted by fleets at an increasing rate.[856] However, the Committee noted that there are no standards for performance, display, and system validation. The Committee recommended that NHTSA issue a white paper to clarify the minimum performance needed from these systems from a safety perspective.[857] This recommendation addresses the effects of tire pressure systems on vehicle safety. Because the recommendation for a white paper relates to safety, and is not directed at fuel efficiency or GHG emissions effects, the agencies are not responding to the NAS recommendation in this proposal.

Nevertheless, the agencies note that automatic tire inflation systems can improve fuel efficiency and greenhouse gas emissions (see Preamble Section III/draft RIA Chapter 2) by maintaining tire pressure close to the tire pressure specification. The agencies are proposing to recognize automatic tire inflation systems as a technology that improves fuel efficiency for tractors, trailers and vocational vehicles in the GEM vehicle compliance model.

(d) Will NHTSA survey private fleets or leverage government fleets to gather information for the Phase 2 rulemaking?

In its report, the NAS Committee found that there are many additional methods by which NHTSA could gather fleet information to inform the Phase 2 rulemaking. The Committee recommended that NHTSA gather data from private fleets, and work with the General Services Administration or United States Postal Service to evaluate the fleet of vehicles they possess.[858 859]

NHTSA understands that additional fleet information could be helpful for purposes of formulating medium- and heavy-duty fuel efficiency standards. Due to the length of time necessary to capture useful, relevant data from fleets, NHTSA was unable to conduct public or private fleet studies to inform this rulemaking. NHTSA will take these recommendations under advisement to inform the agency in the future. For the time being, the agencies have utilized data from FHWA, EPA's SmartWay program, Polk, and other sources of fleet information.

(e) GEM Inputs and Outputs

The NAS Committee found that GEM Version 2.0.1 is not compatible with automated order entry systems of OEMs.[860] It recommended that the GEM programmers configure GEM to be compatible with existing OEM order entry systems[861] and provide a more useful output that includes graphs and other presentation methods.[862] However, EPA believes these recommendations are beyond the scope of this rulemaking.

(f) OEM-Specific Code

The NAS committee stated models should be capable of simulating real-world component behavior, and should not be oversimplified.[863] It recommended allowing OEMs to substitute OEM-specific models or code for the fixed models in the current GEM, including substituting a power pack (the engine, aftertreatment, transmission).[864] However, as described in Section II, we are not proposing to allow this for a number of reasons. NAS explained that its goal was to reflect real-world operation accurately. We believe the powertrain test option could be used to achieve this goal.

[852] *Id.* at 36, Recommendation 3.4, 6.6 p 84.

[853] *Id.* at 84, Recommendation 6.6.

[854] *Id.* at 36, Recommendation 3.4.

[855] 76 FR 57182–57185.

[856] *Phase 2 First Report* at 84.

[857] *Id.,* Recommendation 6.4.

[858] *Id.* at 43, Recommendation 4.2, 4.3, and 4.4.

[859] *Id. at 11, Recommendation 1.3.*

[860] *Id.* at 35.

[861] *Id.,* Recommendation 3.2.

[862] *Id.,* Recommendation 3.3.

[863] *Id.* at 37.

[864] *Id.,* Recommendation 3.7.

(3) NAS Findings and Recommendations With Which the Phase 2 Standards Are Less-Significantly Inconsistent

(a) What are the agencies doing with respect to fuel specifications for natural gas?

The Committee found that natural gas provides a potential long-term price advantage backed by an abundant supply.[865] In addition to its other natural gas (NG)-specific recommendations, the Committee recommended government and the private sector should support further technical improvements in engine efficiency and operating costs, reduction of storage costs, and emission controls (as is done for diesel engines).[866] Further, it recommended that NHTSA and EPA should also evaluate the need for and benefits and costs of an in-use NG fuel specification for motor vehicle use.

The agencies recognize the value in evaluating an in-use NG fuel specification for motor vehicle use. EPA has developed and promulgated fuel specifications for other motor vehicle fuel types, both for test fuels and for in-use fuels. Such fuel specifications established by EPA usually complement fuel specifications established by third party organizations such as ASTM.

EPA has established fuel specifications for natural gas used as test fuels for emissions testing,[867] but has not adopted specifications for in-use natural gas used as a motor vehicle or off-highway fuel. However, states have set natural gas quality limits on the natural gas sold within the state, and natural gas pipelines have established specifications for the natural gas either for their own purposes or to ensure that the natural gas being transported by its pipeline will be usable within the states to which the pipeline transports the natural gas. These specifications would apply to natural gas used as a motor vehicle fuel.

EPA may consider establishing in-use specifications for natural gas used as a motor vehicle or off-highway fuel in the future. However, because natural gas use within the transportation sector is currently so small (less than 1 percent of total natural gas demand and less than 1 percent of heavy-duty fuel demand), its use for transportation would not have a separate fuel supply system, and it would not make sense that such a small user segment should dictate fuel quality for the overall fuel supply. Like other potential regulations that EPA might consider, EPA will consider establishing fuel quality regulations on natural gas if and when its use increases as a fuel for the transportation sector.

(b) Have the agencies considered low rolling resistance standards for all new tires?

With regard to low rolling resistance tires, the NAS Committee found that 70 percent of new tires sold in 2012 were for replacement of existing tires.[868] It found that although most new tractors and trailers come equipped with SmartWay verified tires, only 42 percent of replacement tires are SmartWay verified.[869] The Committee recommended that NHTSA and EPA evaluate rolling resistance of new tires, especially those sold as replacements.[870] It recommended that NHTSA adopt a regulation establishing a low rolling resistance standard for all new tires designed for tractor and trailer use.[871]

The agencies are proposing to include low rolling resistance tires as a technology that may be used for compliance for fuel efficiency and GHG standards. The agencies conducted tire rolling resistance testing and considered confidential business information data provided by several tire manufacturers, which is discussed in Preamble Sections III, IV, and V and draft RIA Chapter 2. The agencies have focused our resources and attention to develop standards for new vehicles and engines. NHTSA has not conducted work to consider a rolling resistance performance standard for replacement tires at this time and will take the Committee's recommendation under advisement.

(c) Have the agencies considered a protocol for measuring and reporting the coefficient of rolling resistance to aid in consumer selection?

The Committee recommended that the agencies consider establishing a protocol for measuring and reporting the coefficient of rolling resistance to aid in consumer selection, similar to passenger car tires.[872] At this time, the agencies are taking the Committee's recommendation under advisement.

(d) What other revisions are the agencies making to GEM?

Consistent with the NAS Committee's recommendations, the agencies are proposing to make the following revisions to GEM, as also detailed Preamble Section II:

Allowing manufacturers to input parameters related to engines, transmissions, and axles

- Basing GEM on a steady-state fuel map
- Allowing separate fuel maps for alternative fuels
- Including real-world road grade to highway cycles
- Use of wind-average drag coefficients for aerodynamic inputs

However, the agencies are not making other changes recommended by NAS. We are not making the user interface changes recommended by the Committee on behalf of manufacturers. Our recent discussions with manufacturers indicate that they have adopted ordering systems that are consistent with the current interface. We are also not revising GEM to allow manufacturers to input their own shift strategies. Instead, we are proposing a powertrain test option that would serve the same purpose.

The NAS Committee also recommended that we broaden GEM to allow for additional duty-cycles and actual vehicle weights. We believe that such changes would not significantly improve the overall program, but would add significant complexity.

(e) Vehicle Weight and Payload in GEM

The NAS Committee recommended that NHTSA evaluate the load specific fuel consumption (LSFC) at more than one payload to ensure there is not an undesirable acute sensitivity to payload by a particular truck power train and to reflect the fact that some states allow vehicles to operate with gross combination vehicle weight ratings well in excess of the values adopted for the simulation. NAS also recommended that GEM allow manufacturers to input actual vehicle weights.[873]

As described in Section III, the agencies are proposing to modify GEM to allow heavy-haul vehicles to be certified separately, to reflect their unique weight and payload attributes. However, are not proposing to allow for other payloads or weights to minimize complexity during the compliance process.

[865] *Id.* at 65.

[866] *Id.,* Recommendation 5.4.

[867] EPA set natural gas test fuel quality for light-duty and heavy-duty engines in 1994 (40 CFR 86.113–94 and 86.1313–94, respectively), and for nonroad engines in 2002 (40 CFR 1065.715).

[868] *Id.* at 84.

[869] *Id.*

[870] *Id.,* Recommendation 6.5.

[871] *Id.*

[872] Id. at 14, Recommendation 1.8.

[873] *Id.* at 9, Recommendation 1.1.

(f) Is NHTSA conducting any campaigns related to fuel efficient driving behaviors?

In the NAS Committee's Phase 1 report,[874] the Committee concluded that fuel saving opportunities exist if drivers are educated about fuel efficient driving techniques.[875] The Phase 2 reiterated this finding, and recommended NHTSA encourage and incentivize the dissemination of information related to the relationship between driver behavior and fuel savings.[876]

Based on NHTSA's understanding of the medium- and heavy-duty segments, a large portion of the vehicles are driven professionally. Professional drivers operate these vehicles as independent drivers and in trucking fleets. In some instances, particularly larger fleet operations, management will track and encourage driver fuel efficiency. It is not uncommon for professional drivers across all types of trucking operations to undergo private fuel efficiency training. For these reasons, NHTSA has not yet undertaken dissemination of information related to the relationship between driver behavior and fuel savings.

XIII. Amendments to Phase 1 Standards

The agencies are proposing revisions to the regulatory text specifying test procedures and compliance provisions used for Phase 1. For the most part, these amendments would apply exclusively to the Phase 2 rules. In a few limited instances, the agencies are proposing to apply some of these changes to Phase 1. These limited changes to the Phase 1 program are largely conforming amendments, and are described below, along with other proposed minor changes to the Phase 1 compliance program. We note, however, that we are not reopening the Phase 1 rules in a general sense, nor are we requesting comment on the stringency of the Phase 1 standards or other fundamental aspects of the Phase 1 program.

A. EPA Amendments

(1) Pickups and Vans

EPA is proposing to relocate the GHG standards and other regulatory provisions for chassis-certified HD pickups and vans in the Code of Federal Regulations from 40 CFR 1037.104 to 40 CFR 86.1819–14. Accordingly, NHTSA will modify any of EPA's references in 49 CFR parts 523 and 535 to accommodate the migration. EPA is making this change largely to address ambiguities regarding the application of additional provisions from 40 CFR part 86, subpart S, for these vehicles. The approach in 40 CFR 1037.104 was to state that all of 40 CFR part 86, subpart S, applies except as specified in 40 CFR 1037.104; however, the recent standards adopted for light-duty vehicles and light-duty trucks included several changes to 40 CFR part 86, subpart S, that should not apply for chassis-certified HD pickups and vans. Based on our experience implementing the Phase 1 program, we believe it is appropriate to include the GHG standards for chassis-certified HD pickups and vans in the same part as light-duty vehicles (40 CFR part 86, subpart S). All other certification requirements for these heavy-duty vehicles—criteria exhaust standards, evaporative and refueling standards, provisions for onboard diagnostics, and the range of certification and compliance provisions—are in that subpart. We note that we have not experienced the same challenges for other heavy-duty vehicles, and are therefore not proposing to relocate the other provisions of 40 CFR part 1037.

This migration has highlighted a few areas where we need to clarify how the regulations apply for chassis-certified HD pickups and vans. In particular, EPA is proposing to make the following changes:

- Clarify that the GHG standards apply at high-altitude conditions
- State that fleet-average calculation of carbon-related exhaust emissions (CREE) is not required for chassis-certified HD pickups and vans
- Clarify that requirements related to model types and production-weighted average calculation apply on any passenger automobiles and light trucks
- State that the credit and debit provisions of 40 CFR 86.1865–12(k)(5) do not apply for chassis-certified HD pickups and vans

Clarify that the Temporary Lead Time Allowance Alternative Standards in 40 CFR 86.1865–12(k)(7) do not apply for chassis-certified HD pickups and vans

- State that the early credit provisions of 40 CFR 86.1866–12, 86.1867–12, 86.1868–12, 86.1869–12, 86.1870–12, and 86.1871–12 do not apply for chassis-certified HD pickups and vans

(2) Heavy-Duty Engines

As described in Section II, EPA is proposing to revise the approach to classifying gaseous-fuel engines with respect to both GHG and criteria emission standards. This does not affect the vehicle-based standards that apply under 40 CFR part 1037. The general approach would be to continue to divide these engines into spark-ignition and compression-ignition categories, but we propose to always apply the compression-ignition standards to gaseous-fuel engines that qualify as medium heavy-duty or heavy heavy-duty engines. Currently, any gaseous-fuel engine derived from a gasoline engine would be subject to the spark-ignition standards no matter the weight class of the vehicle. As described in Section II, EPA now believes this approach does not reflect the reality that gaseous-fuel engines used in Class 6, 7, or 8 vehicles compete with diesel engines rather than gasoline engines. Such engines compete directly with diesel engines, and we believe they should be required to meet the same emission standards. Because all current gaseous-fuel engines for these large vehicles are already being certified to the compression-ignition engine standards we can propose to also apply this approach to engines subject to the HD GHG Phase 1 standards without adverse impacts on any manufacturers.

EPA is also proposing to revise the regulation to spell out how to apply enforcement liability for a situation in which the *engine* manufacturer uses deficit credits for one or more model years. Simply put, any time an engine manufacturer is allowed to carry a deficit to the next year, all enforcement liability for the engines that generated the deficit are extended for another year. These provisions are the same as what we have already adopted for heavy-duty *vehicles* subject to GHG standards under 40 CFR part 1037.

(3) Evaporative Emission Testing for LNG Vehicles

Heavy-duty vehicles fueled by natural gas have for many years been subject to evaporative emission standards and test procedures. While fuel systems containing gasoline require extensive design features to handle vented fuel, fuel systems containing natural gas generally prevent evaporative losses by remaining sealed. In the case of compressed natural gas, there is a

[874] Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles; National Research Council; Transportation Research Board (2010). ''Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,'' (''NAS Report''), at page 9. Washington, DC, The National Academies Press. Contract DTNH22–08–H–00222. Available electronically from the National Academy Press Web site at *http://www.nap.edu/catalog.php?record.id=12845* (last accessed September 10, 2014.)

[875] *Id.* at 177.

[876] *Phase 2 First Report* at 14, Recommendation 1.8.

voluntary consensus standard, ANSI NGV1–2006, that is designed to ensure that there are no leaks or losses during a refueling event. Since compressed natural gas systems remain sealed indefinitely once the refueling event is complete, we understand that complying with the ANSI refueling standard is sufficient to demonstrate that the vehicle also complies with all applicable evaporative emission standards. The Light-Duty Tier 3 final rule included provisions to clarify that compressed natural gas systems meeting the applicable ANSI standard are deemed to comply with EPA's evaporative emission standards.

Systems using liquefied natural gas (LNG) behave similarly, except that the cryogenically stored fuel needs to be vented to prevent an over-pressure situation if the vehicle is not used for an extended time, as described in Section XI. Such vehicles are currently subject to evaporative emission standards and test procedures, though there are some substantial questions about how one can best apply the procedures to these systems; not all of the instructions about preconditioning the vehicle are straightforward for cryogenic fuel systems with no evaporative canister. EPA is interested in pursuing an approach that is similar to what applies for compressed natural gas systems, which would need some additional attention to address boil-off emissions. There are two voluntary consensus standards that specify recommended practices to lengthen the time before boil-off starts to occur for LNG systems. SAE J2343 specifies a minimum five-day hold time and NFPA 52 specifies a minimum three-day hold time. EPA is proposing to require that manufacturers of LNG vehicles meet the SAE J2343 standard as a means of demonstrating compliance with the evaporative emission standards.

While the hold-time requirements of SAE J2343 and NFPA 52 are clear, there appears to be very little description of the procedure to determine how much time passes between a refueling event and initial venting. To ensure that all manufacturers are subject to the same set of requirements, we are proposing to include a minimal set of specifications corresponding to the demonstration under SAE J2343. In particular, EPA proposes to specify that the vehicle must remain parked throughout the measurement procedure, ambient temperatures must remain between 20 and 30 °C, the refueling event must follow conventional procedures corresponding to the vehicle's hardware, and no stabilization step is allowed after the refueling event.

The proposed rules provides for relying on compliance with SAE J2343 as a means of demonstrating compliance with evaporative emission standards immediately upon completion of the final rule. EPA is proposing to make this mandatory for vehicles produced on or after January 1, 2020.

EPA requests comment on all aspects of the proposed provisions for LNG vehicles.

(4) Compliance and Other General Provisions

EPA proposes the following changes that apply broadly for different types of vehicles or engines:

- Add a requirement for vehicle manufacturers that sell incomplete vehicles to secondary vehicle manufacturers to provide emission-related assembly instructions to ensure that the completed vehicle will be in a certified configuration.
- Specify parameters for determining a vehicle's curb weight, consistent with current practice for vehicles certified under 40 CFR part 86, subpart S.
- Revise the recordkeeping requirement to specify a uniform eight-year retention period for all data supporting an application for certification. The provision allowing for one-year retention for ''routine data'' is no longer necessary now that data collection is all recorded in electronic format. EPA is also clarifying that the eight-year retention period is calculated relative to the latest associated application for certification, not from the date the data were generated.
- Change the rounding for analytically derived CO_2 emission rates and target values from the nearest 0.1 g/mile to the nearest 1 g/mile.
- Clarify that manufacturers may not amend an application for certification after the end of the model year, other than to revise maintenance instructions or family emission limits, as allowed under the regulations. Remove the general recordkeeping provisions from 40 CFR 1037.735 that are already described in 40 CFR 1037.825.
- Require a different equation with a ratio of 0.8330 in 40 CFR 1037.521(f) when full yaw sweep measurements are used to determine wind averaged drag correction to establish an equivalent method to the equation using ±6 degree measurements (note that this cite is proposed to be redesignated as 40 CFR 1037.525(d)). This proposed change would not impact stringency because manufacturers are already subject to compliance using both methods—full yaw sweep and ±6 degree measurements. In addition, this Phase 1 flexibility was not used in setting the level of the Phase 1 standards.
- Clarify how EPA would conduct selective enforcement audits (SEAs) for engines (in 40 CFR 1036.301) and vehicles (in 40 CFR 1037.301) with respect to GHG emissions.

B. Other Compliance Provisions for NHTSA

(1) Standards and Credit Alignment

In Phase 1, the agencies intended GHG and fuel consumption standards for segments of the National Program to be in alignment so that manufacturers would not be required to build vehicles to meet in equivalent standards. Despite the intent, NHTSA and EPA have identified several scenarios where credits and compliance to both sets of standards are not aligned. This misalignment can have various impacts on compliance with the National Program.

For example, a manufacturer of tractors could have two vehicle families that with same number of vehicles but with opposite and equal compliance margins with standards. In this scenario, the first family would over-comply with the GHG standard while the second family would under-comply with the GHG standard by the same amount of grams CO_2/ton-mile. In calculating credits, the manufacturer would have a net of zero GHG credits and exactly meet compliance; however, based on conversions and rounding of the standard and performance results that manufacturer could end up earning credits or having a credit deficit under NHTSA's fuel efficiency program.

In order to correct this misalignment, NHTSA is proposing to amend the existing fuel consumption standards and the method for calculating performance values for all compliance categories by increasing the significant digits in these conversion values. Increasing the significant digits in these values will result in more precise alignment when converting from GHG consumption standards to fuel consumption standards.

The rounding approach differs for heavy-duty pickup trucks and vans set apart from other vehicle and engine compliance categories. Heavy Duty Pickup Trucks and Vans (HD PUV) use the same approach for calculating standards and performance values as the LD CAFE and GHG programs. As such, NHTSA proposes to increase the required significant values for each components used in these calculations. More specifically, NHTSA proposes to increase the number of decimal places for sub-configuration target standards, the sub-configuration fuel consumptions, the fleet average target standard and the fleet average fuel consumption values from two fixed values and increases them by one additional significant digit. The regulation currently specifies rounding to these values nearest 0.01 and under the proposed approach the values would be rounded to the nearest 0.001.

NHTSA is also proposing to modify the c and d target coefficients used for deriving HD PUV target standards. These values are directly convertible from the EPA a and b target coefficients, respectively. Currently, the c target coefficient contains six decimal places and the d target coefficient contains two decimal places. Each coefficient would be increased by one decimal—meaning the c target coefficient would have seven decimal places, with the last four being significant digits—and the d target coefficient would be increased to three decimal places, with there being a total of four significant digits. The modifications to the rounding and level of precision of these six values will not entirely eliminate the misalignment of the credits being calculated for EPA and NHTSA but will reduce it to an insignificant variance.

For other compliance categories, a similar approach can be used to address the misalignment of calculated credits as it pertains to vocational vehicles, tractors, and heavy duty engines. NHTSA proposes to increase the number of significant digits by increasing the decimal places contained in the standards and the FEL for the vocational vehicle and tractor segments and the FCL for the engine segments to four decimal places. Currently, the vocational vehicle and tractor standards and FELs contain one decimal place while engines standards and FELs contain two decimal places. The standards will be identified directly in the regulation while the FEL and FCL will be a calculated value rounded to the nearest 0.0001.

The modifications to the rounding and level of precision of these values should eliminate the misalignment of the credits being calculated.

These changes are planned for implementation retroactively starting for the model year 2013 standard. However, because the stringency of the Phase 1 fuel consumption standards may be adversely impacted for certain manufacturers who have already developed engineering plans considering previous credit balance, we propose to seek comments on whether optional compliance should be allowed.

(2) Off-Road Exclusion Petition Process for Tractors and Vocational Vehicles

In the Phase 1 final rule, the agencies added provisions for certain types of vocational tractors and vocational vehicles that operate off-road to be exempt from standards, although standards would still apply to the engines installed in these vehicles. An exemption was warranted because these vehicles operate in a manner essentially making them incompatible with fuel saving and emission reduction technologies, such as performing work in an off-road environment, being speed restricted, or having off-road components or other features making them incompatible for roadways. For the Phase 1 program, off-road vehicle manufacturers meeting the exemption provisions are required to provide EPA and NHTSA, through the EPA database, a report within 90 days after the end of each model year identifying its off-road vehicles. The report must provide a description of each excluded vehicle configuration, including an explanation of why it qualifies for the exclusion and the production volume. A manufacturer having an off-road vehicle failing to meet the criteria under the agencies' off-road exemptions explained in 40 CFR 1037.631 and 49 CFR 523.6 is allowed to submit a petition as required in 49 CFR 535.8 describing how and why its vehicles should qualify for exclusion.

Under Phase 1 compliance processes, manufacturers have not been using the petitioning process when seeking clarification on off-road vehicles not meeting the strict interpretation of the provision. Instead, manufacturers are submitting information to EPA in advance of the end of the model year to determine whether or not these vehicles are exempted and to determine whether it is necessary to submit any applications for certificates of conformity as required by 40 CFR 1037.201. EPA and NHTSA collaboratively determine whether manufacturers are exempted and EPA shares the decision with the manufacturer. The current process followed by the agencies makes it unnecessary to use the petitioning process and has the added advantage of providing a joint determine early enough in the model year whereas disapproved manufacturer have adequate enough time to submit applications for certificates of conformity.

For the Phase 1 standards, the agencies are proposing to delete the petitioning process and add provisions for manufacturers seeking clarification on the qualifications of an off-road vehicle exemption to send information to the agencies through EPA in advance of the model year in order for us to make an appropriate determination. EPA plans to add these provisions into its regulations as a part of 40 CFR 1037.150(h). Removal of the formal petition process is intended to minimize the impact on manufacturers that are seeking an off-road exemption while allowing the agencies to be proactive in making a determination based on the criteria and individual merits of the vehicles being requested for an exemption. Collaboration between the agencies in making a decision about exemptions outside a formal petition process should streamline the timing for a response and reduce the burden upon the agencies and manufacturers.

(3) Innovative Technology Request Documentation Specifications

For vehicle and engine technologies that can reduce GHG and fuel consumption, but for which there is not yet an established method for quantifying reductions, the agencies encourage the development of such technologies through providing ''innovative technology'' credits. Manufacturers seeking innovative technology credits must quantify the reductions in fuel consumption and GHG emissions that the technology is expected to achieve, above and beyond those achieved on the existing test procedures.

Manufacturers submitting innovative technology requests must send a detailed description of the technology and a recommended test plan to EPA as detailed in 40 CFR 1036.610 and 40 CFR 1037.610. The test plan must include whether the manufacturer is applying for credits using the improvement factor method or the separate-credit method. It is recommended that manufacturers not conduct testing until the agencies can collaboratively approve the test plan in which a determination is made on the qualification of the technology as innovative. EPA and NHTSA also make the decision at that time whether to seek public comments on the test plan if there are unknown factors in the test methodology.

Under the current regulations, EPA and NHTSA have reviewed several test plans from manufacturers seeking innovative technology credits. The agencies have received feedback from manufacturers that the final approval process is not clearly defined, which has caused a substantial time commitment from manufacturers. To address this feedback, the agencies are proposing to add further clarification in 40 CFR 1036.610 and 40 CFR 1037.610

defining the steps manufacturers must follow after an approval is granted for a test plan. This includes specifications for submitting the final documentation to the agencies for final approval and for determining credit amounts. The agencies are adding the same level of detail as required for the final documentation required in EPA's light duty off-cycle program in 40 CFR 86.1869–12(e)(2). These specifications should provide manufacturers with a clear understanding of the required documentation and approval process to reduce the time burden placed on manufacturers.

NHTSA also proposes to add similar provisions from its light duty CAFE program specified in 49 CFR 531.6(b)(2) and 533(c)(2) for limiting the approval of innovative technologies under its program for those technologies related to crash-avoidance technologies, safety critical systems or systems affecting safety-critical functions, or technologies designed for the purpose of reducing the frequency of vehicle crashes. NHTSA prohibited credits for these technologies under any circumstances in its CAFE program (see 77 FR 62730). NHTSA believes a similar strategy is warranted for heavy-duty vehicle as well. Further, the evaluation of crash avoidance technologies is better addressed under NHTSA's vehicle safety authority than under a case-by-case innovative technology credit process.

(4) Credit Acquisition Plan Requirements

The National Program was designed to provide manufacturers with averaging, banking and trading (ABT) flexibilities for meeting the GHG and fuel efficiency standards to optimize the effectiveness of the program. As a part of these flexibilities, manufacturers generating a shortfall in fuel consumption credits for a given model year must submit a credit plan to NHTSA describing how it plans to resolve its deficits within 3 models year. To assist manufacturers, NHTSA is proposing to modify 49 CFR 535.9(a)(6) of its regulation to clarify and provide guidance to manufacturers on the requirements for a credit allocation plan which contains provisions to acquire credits from another manufacturer which will be earned in future model years.

The current regulations do not specify if future credit acquisition is permitted or not and the revision is intended to clarity that it is, with respect to the limitation a credit shortfall can only be carried forward three years. Providing this clarification is intended to increase transparency within the program and ensure all manufacturers are aware of its available flexibilities.

In addition to providing this clarification, the regulation is also being amended to outline the requirement that in order for a credit allocation plan containing this provision to be reviewed for approval, NHTSA will require an agreement signed by both manufacturers. This requirement will assist NHTSA with its determination that the credits will become available to the acquiring manufacturer given they are earned.

(5) New Vehicle Field Inspections and Recordkeeping Requirements

Previously, NHTSA decided not to include recordkeeping provisions in its regulations for the Phase 1 program. EPA regulations include recordkeeping requirements in 40 CFR 1036.250, 1036.735, 1036.835, 1037.250, 1037.735, and 1037.835. For the Phase 2 program, NHTSA is proposing to add recordkeeping provisions to facilitate its compliance validation program. For the Phase 1 program, manufacturers test and conduct modeling to determine GHG emissions and fuel consumption performance, and EPA and NHTSA perform validation testing. EPA uses the results of the validation tests to create a finalized report that confirms the manufacturer's final model year GHG emissions and fuel consumption results. Each agency will use this report to enforce compliance with its standards.

NHTSA assesses compliance with fuel consumption standards each year, based upon EPA final verified data submitted to NHTSA for its heavy-duty vehicle fuel efficiency program established pursuant to 49 U.S.C. 32902(k). NHTSA may also conduct verification testing throughout a given model year in order to validate data received from manufacturers and will discuss any potential issues with EPA and the manufacturer. See 49 CFR 535.9. After the end of the model year, NHTSA may also decide to conduct field inspections in order to confirm whether or not a new vehicle was manufactured as originally certified. NHTSA may conduct field inspections separately or in coordination with EPA. To facilitate inspections, the agencies propose to add additional provisions to the EPA recordkeeping provisions to require manufacturers to keep build documents for each manufactured tractor or vocational vehicle. Each build document would be required to contain specific information on the design, manufacturing, equipment and certified components for a vehicle. NHTSA would request build documents through EPA and the agencies would collaborate on the finding of all field inspections. Manufacturers would be required to keep records of build documents for a period of 8 calendar years.

XIV. Other Proposed Regulatory Provisions

In addition to the new GHG standards proposed in these rules, EPA and NHTSA are proposing to amend various aspects of the regulations as part of the HD GHG Phase 1 standards for heavy-duty highway engines and vehicles. EPA is also taking the opportunity to propose to amend regulatory provisions for other requirements that apply for heavy-duty highway engines, and for certain types of nonroad engines and equipment. NHTSA is also proposing to amend its regulations to require electronic submission of data for the CAFE program.

A. Proposed Amendments Related to Heavy-Duty Highway Engines and Vehicles

This section describes a range of proposed regulatory amendments for heavy-duty highway engines and vehicles that are not directly related to GHG emission standards. Section XIV.D describes additional changes related to test procedures that affect heavy-duty highway engines.

(1) Alternate Emission Standards for Specialty Heavy-Duty Vehicles

Motor vehicles conventionally comprise a familiar set of vehicles within a relatively narrow set of parameters—motorcycles, cars, light trucks, heavy trucks, buses, etc. The definition of ''motor vehicle;'' however, is written broadly to include a very wide range of vehicles. Almost any vehicle that can be safely operated on streets and highways is considered a motor vehicle. Development of EPA's emission control programs is generally focused on a consideration of the technology, characteristics, and operating parameters of conventional vehicles, and typically includes efforts to address concerns for special cases. For example, the driving schedule for light-duty vehicles includes a variation for vehicles that are not capable of reaching the maximum speeds specified in the Federal Test Procedure.

Industry innovation in some cases leads to some configurations that make it particularly challenging to meet regulatory requirements. We are aware that plug-in hybrid-electric heavy-duty vehicles are an example of this. An engine for such a vehicle would be expected to have a much lower power rating and duty cycle of engine speeds and loads than a conventional heavy-duty engine. The costs of regulatory compliance and the mismatch to the specified duty cycle can make it cost-prohibitive for engine manufacturers to certify such an engine under the heavy-duty highway engine program. EPA's nonroad emission standards have reached a point that involves near parity with the level of emission control represented by the emission standards for heavy-duty highway engines.

To address concerns about certifying heavy-duty engines to highway standards for use in hybrid vehicles, we are therefore proposing to allow manufacturers of heavy-duty highway vehicles the option to install limited numbers of engines certified to alternate standards. Qualifying engines would be considered motor vehicle engines, but they would be certified to standards that are equivalent to those adopted for comparable nonroad engines. Vehicles with hybrid powertrains would be a focus of this allowance. EPA believes the same principles apply for amphibious vehicles and for vehicles with maximum speed at or below 45 miles per hour and we are therefore proposing to apply the same provisions to these additional vehicles.

Under this approach, compression-ignition engines could be certified to alternate standards that are equivalent to the emission standards under 40 CFR part 1039, and spark-ignition engines could be certified to alternate standards that are equivalent to the Blue Sky emission standards under 40 CFR part 1048. Engines meeting these alternate emission standards would generally be expected to use the same technologies to control emissions as engines certified to the applicable emission standards for heavy-duty highway engines. EPA would disallow this approach for compression-ignition engines below 56 kW since the nonroad standards for those engines are substantially less stringent than the standards that apply for heavy-duty highway engines. Also, since the nonroad duty cycles would generally better represent the in-use operating characteristics of these vehicles, we would expect the nonroad test procedures to be at least as effective in achieving effective in-use emission control. The regulations at 40 CFR part 1048 include a simplified form of diagnostic controls, and we are proposing in these rules to include simplified diagnostic controls for 40 CFR part 1039. These engine-based diagnostic controls would substitute for the diagnostic requirements that would otherwise apply under 40 CFR 86.010–18.

It may also be appropriate to allow manufacturers of such heavy-duty vehicles to use an engine from a smaller vehicle that is already covered by chassis-based certification under 40 CFR part 86, subpart S. Many of the heavy-duty vehicles described under this section would be adequately powered by lower-displacement automotive engines, and the level of emission control would clearly be expected to match or exceed that of engines certified to the heavy-duty standards that would otherwise apply. However, engines used in chassis-certified vehicles involve some degree of calibration that relates engine operation to vehicle parameters. Adapting these engines to heavy-duty vehicles would therefore require some recalibration, which could involve changing the effectiveness of emission controls. It is also unclear how the heavy-duty vehicle would be designed for onboard diagnostic controls. EPA requests comment on the technical and regulatory issues surrounding the use of engines from chassis-certified vehicles in certain heavy-duty vehicles.

These alternate standards relate only to the engine certification-based emission standards and certification requirements. All vehicle-based requirements for evaporative and greenhouse gas emissions would continue to apply as specified in the regulation.

This allowance is intended to lower the barrier to introducing innovative technology for motor vehicles. It is not intended to provide a full alternative compliance path to avoid certifying to the emission standards and control requirements for highway engines and vehicles. To accomplish this, EPA is proposing to allow a manufacturer to produce no more than 1,000 hybrid vehicles in a single model year under this program, and no more than 200 amphibious vehicles or speed-limited vehicles.

California ARB is in the process of developing similar provisions for a reduced compliance burden for a limited number of highway vehicles toward the goal of incentivizing hybrid vehicles and other advanced technology. EPA expects to be involved in that policy development and would be interested in aligning programs as much as possible. It may be necessary or appropriate for the final rule to include a reference to any new policy that has been adopted by California ARB in the meantime.

EPA requests comment on all aspects of this program to create alternate motor-vehicle emission standards that allow certified nonroad engines to be used in the identified types of heavy-duty highway vehicles.

(2) Chassis Certification of Class 4 Heavy-Duty Vehicles

In the HD Phase 1 rule, the agencies included a provision allowing manufacturers to certify Class 4 and larger heavy-duty vehicles to the chassis-based emission standards in 40 CFR part 86, subpart S. This applied for greenhouse gas emission standards, but not criteria emission standards. EPA revisited this issue in the recent Tier 3 final rule, where we revised the regulation to allow this same flexibility relative to exhaust emission standards for criteria pollutants. However, this change to the regulation conflicted with our response to a comment in that rulemaking that EPA should not change the certification arrangement for criteria pollutants.

Manufacturers have taken opposing views of the proper approach for vehicles above 14,000 lbs GVWR. EPA requests comment on how best to address this issue in a way that resolves the various and competing concerns. In particular, EPA requests comment on the following specific areas of interest:

- Should EPA treat 14,000 lbs as a bright line to disallow any certification of larger vehicles to the chassis-based exhaust emission standards?
- Should EPA allow for certifying the larger vehicles to the chassis-based standards, but identify certain criteria to narrow the scope of this allowance? For example, EPA could limit this to compression-ignition or spark-ignition engines, we could identify a maximum GVWR value above which chassis-based certification is not allowed, or EPA could limit this allowance to vehicles that share design characteristics with chassis-certified vehicles below 14,000 lbs GVWR (as California ARB has done).
- If EPA allows for certifying the larger vehicles to the chassis-based standards, what additional amendments are needed to clarify how to apply the requirements of 40 CFR part 86, subpart S? For example, some further specification may be needed to identify how to apply requirements related to emission standards, driving schedule, and emission credits?

(3) On-Board Diagnostics for Heavy-Duty Vehicles

EPA defines the onboard diagnostic requirements for heavy-duty vehicles above 14,000 lbs GVWR in 40 CFR 86.010–18, but we allow manufacturers to meet OBD requirements based on the requirements adopted by the California Air Resources Board. Manufacturers in almost all cases certify based on the California procedures instead of EPA procedures. Certification based on EPA procedures is limited to certain spark-ignition engine families whose certification is limited to states other than California. EPA requests comment on a change to EPA regulation that simply requires that manufacturers meet the California requirements. EPA has taken a similar approach for vehicles at or below 14,000 lbs GVWR, as described in 40 CFR 86.1806–17. Under this approach, EPA would recognize California ARB's approval as valid for EPA certification. EPA requests comment on this approach. In particular, EPA requests comment on the need to preserve EPA specifications for on-board diagnostics for any special situations, and on the need to make any adjustments or allowances from the California ARB regulations to work for EPA implementation.

(4) Nonconformance Penalties (NCPs)

The Clean Air Act requires that heavy-duty standards for criteria pollutants such as NO_X must reflect the greatest degree of emission reduction achievable through the application of technology that EPA determines will be available. Such ''technology-forcing'' standards create the risk that one or more manufacturers may lag behind in the development of their technology to meet the standard and, thus, be forced out of the marketplace. Recognizing this risk, Congress enacted CAA section 206(g) (42 U.S.C. 7525(g)), which requires EPA to establish ''nonconformance penalties'' to protect these technological laggards by allowing them to pay a penalty for engines that temporarily are unable to meet the applicable emission standard, while removing any competitive advantage those technological laggards may have.

On September 5, 2012, EPA adopted final NCPs for heavy heavy-duty diesel engines that could be used by manufacturers of heavy-duty diesel engines unable to meet the current oxides of nitrogen (NO_X) emission standard. On December 11, 2013, the U.S. Court of Appeals for the District of Columbia Circuit issued an opinion vacating that Final Rule. It issued its mandate for this decision on April 16, 2014, ending the availability of the NCPs for the current NO_X standard, as well as vacating certain amendments to the NCP regulations due to concerns about inadequate notice. In particular, the amendments revise the text explaining how EPA determines when NCP should be made available. EPA is proposing to remove the vacated regulatory text specifying penalties, and re-proposing most of the other vacated amendments to provide fuller notice. Finally, EPA is proposing a new 40 CFR 86.1103–2016 to replace the existing 40 CFR 86.1103–87.

(a) Vacated Penalties

In EPA's regulations, NCP penalties are calculated from inputs specific to the standards for which NCPs are available. The input values are specified in 40 CFR 86.1105–87. EPA is proposing to remove paragraph (j) of this section which specifies the vacated inputs for the 2010 NO_X emission standard. EPA does not request comment on this change because this text has already been vacated by the Court. Since all manufacturers are currently complying with these standards, the text also no longer has any purpose.

(b) Re-Proposed Text

The 2012 rule made amendments to four different sections in 40 CFR part 86. The amendments to 40 CFR 86.1104–91 and 86.1113–87 were supported during the rulemaking and were not questioned in the Court's decision. Nevertheless, these revisions were vacated along with the rest of the rule. EPA is re-proposing these changes. Since we are proposing to vacate and restore the regulatory text, the proposal consists of leaving these sections of the regulations unchanged.

(i) Upper Limits

The changes to 40 CFR 86.1104–91 affected the upper limit. The upper limit (UL) is the emission level established by regulation above which NCPs are not available. A heavy duty engine cannot use NCPs to be certified for a level above the upper limit. CAA section 206(g)(2) refers to the upper limit as a percentage above the emission standard, set by regulation, that corresponds to an emission level EPA determines to be ''practicable.'' The upper limit is an important aspect of the NCP regulations not only because it establishes an emission level above which no engine may be certified using NCPs, but it is also a critical component of the cost analysis used to develop the penalty rates. The regulations specify that the relevant costs for determining the COC50 and the COC90 factors are the difference between an engine at the upper limit and one that meets the applicable standards (see 40 CFR 86.1113–87).

The regulatory approach adopted under the prior NCP rules sets the upper limit at the prior emission standard when a prior emission standard exists and is then changed to become more stringent. EPA concluded that this upper limit should be reasonably achievable by all manufacturers with engines or vehicles in the relevant class. It should be within reach of all manufacturers of HD engines or HD vehicles that are currently allowed so that they can continue to sell their engines and vehicles while finishing their development of fully complying engines. A manufacturer of a previously certified engine or vehicle should not be forced to immediately remove a HD engine or vehicle from the market when an emission standard becomes more stringent. The prior emission standard generally meets these goals because manufactures have already certified their vehicles to that standard.

EPA proposes to revise the regulations in 40 CFR 86.1104–91 to clarify that EPA may set the upper limit at a level below the previous standard if we determine that the lower level is achievable by all engines or vehicles in the relevant subclass. This was the case for the vacated NCP rule. EPA also proposes that we may set the upper limit at a level above the previous standard in unusual circumstances, such as where a new standard for a different pollutant or other requirement effectively increases the stringency of the standard for which NCPs would apply. This occurred for heavy heavy-duty engines with the 2004 standards.

(ii) Payment of Penalties

The proposed changes to 40 CFR 86.1113–87 correct EPA organizational units and mail codes to which manufacturers must send information. The previous information is no longer valid.

(c) Criteria for the Availability of NCPs

Since the promulgation of the first NCP rule in 1985, subsequent NCP rules generally have been described as continuing ''phases'' of the initial NCP rule. The first NCP rule (Phase I), sometimes referred to as the ''generic'' NCP rule, established three basic criteria for determining the eligibility of emission standards for nonconformance penalties in any given model year (50 FR 35374, August 30, 1985). (For regulatory language, see 40 CFR 86.1103–87). The first criterion is that the emission standard in question must become more difficult to meet. This can occur in two ways, either by the emission standard itself becoming more stringent, or due to its interaction with another emission standard that has become more stringent. Second, substantial work must be required in order to meet the emission standard. EPA considers ''substantial work'' to mean the application of technology not previously used in that vehicle or engine class/subclass, or a significant modification of existing technology, in order to bring that vehicle/engine into compliance. EPA does not consider minor modifications or calibration changes to be classified as substantial work. Third, EPA must find that a manufacturer is likely to be noncomplying for technological reasons (referred to in earlier rules as a ''technological laggard''). Prior NCP rules have considered such a technological laggard to be a manufacturer who cannot meet a particular emission standard due to technological (not economic) difficulties and who, in the absence of NCPs, might be forced from the marketplace. During the 2012 rulemaking, some commenters raised issues relating to EPA's interpretation of these criteria:

- The extent to which the criteria are intended to constrain EPA's ability to set NCPs
- The timing for evaluating the criteria
- The meaning of technological laggard

(i) Constraints on EPA

Several commenters argued (implicitly or explicitly) that EPA cannot establish NCPs unless all of the regulatory criteria for NCPs (in 40 CFR 86.1103–87) are met. Some went further to argue that EPA must demonstrate that the criteria are met. However, the actual regulatory text has never stated that EPA may establish NCPs only if all criteria are met, but rather that EPA shall establish NCPs ''provided that EPA finds'' the criteria are met. These criteria were included in the regulations to clarify that manufacturers should not expect EPA to initiate a rulemaking to establish NCPs where these criteria were not met. Moreover, the regulations clearly defer to EPA's judgment for finding that the criteria are met. While EPA must explain the basis of our finding, the regulatory language does not require us to prove or demonstrate that the criteria are met.

This interpretation is consistent with the text of the Clean Air Act, which places no explicit restrictions on when EPA can set NCPs. In fact, it seems to create a presumption that NCPs will be available. The Act actually requires EPA to allow certification of engines that do not meet the standard unless EPA determines the practicable upper limit to be equal to the new emission standard.

To address this confusion, the new proposed regulatory text would explicitly state that where EPA cannot determine if all of the criteria have been met, we may presume that they have. In other words, EPA does not have the burden to prove they have been met.

(ii) Timing for Evaluating Criteria

In order to properly understand the appropriate timing for evaluating each of the NCP criteria, it is necessary to understand the purpose of each. When considered together, these criteria evaluate the likelihood that a manufacturer will be technologically unable to meet a standard on time. However, when EPA initially proposed the NCP criteria, we noted that the first two criteria addressed whether there was a possibility for a technological laggard to develop. When the first criterion is met, it creates the possibility for a technological laggard to exist. When manufacturers must perform substantial work, it is possible that at least one will be unsuccessful and will become a laggard. Thus, when evaluating these first two criteria, the purpose is to determine whether the standard created the possibility for a laggard to exist. The third criterion is different because it asks whether that possibility has turned into a likelihood that a technological laggard has developed. For example, a standard may become significantly more stringent and substantial effort might be required for compliance, but all manufacturers may be meeting the applicable standard. In that situation, a technological laggard is not likely and penalties would be unnecessary.

In this context, it becomes clear that since the first two of these criteria are intended to address the question of whether a given standard creates the possibility for this to occur, they are evaluated before the third criterion that addresses the likelihood that the possibility will actually happen. In most cases, it is possible to evaluate these criteria at the point a new standard is adopted. This is the value of these criteria, that they can usually be evaluated long before there is enough information to know whether a technological laggard is actually likely. For example, where EPA adopts a new standard that is not technology-forcing, but rather merely an anti-backsliding standard, EPA could determine at the time it is adopted that the second criterion is not met so that manufacturers would know in advance that no NCPs will be made available for that standard.

One question that arose in the 2012 rule involved how to evaluate the second criterion if significant time has passed and some work toward meeting the standard has already been completed. To address this question, the proposed regulations would clarify that this criterion is to be evaluated based on actual work needed to go from meeting the previous standard to meeting the current standard, regardless of the timing of such changes. EPA looks at whether ''substantial work'' is or was required to meet the revised standard at any time after the standard was issued—the important question is whether manufacturers who were using technology that met the previous standard would need to build upon that technology to meet the revised standard. Other interpretations would seem to be directly contrary to the purpose of the statute, which is designed to allow technological laggards to be able to certify engines even if other manufacturers have met the standard.

(iii) Technological Laggards

Questions also arose in 2012 about the meaning of the term ''technological laggard''. While the regulations do not define ''technological laggard'', EPA has previously interpreted this as meaning a manufacturer who cannot meet the emission standard due to technological difficulties, not merely economic difficulties (67 FR 51464–51465, August 8, 2002). Some have interpreted this to mean that NCPs cannot be made available where a manufacturer tries and fails to meet a standard with one technology but knew that another technology would have allowed them to meet the standard. In other words, that it made a bad business decision. However, EPA's reference to ''economic difficulties'' applies where a technological path exists—at the time EPA is evaluating the third criterion—that would allow the manufacturer to meet the standard on time, but the manufacturer chooses not to use it for economic reasons. The key question is whether or not the technological path exists at the time of the evaluation. To address this confusion, the proposed regulations would clarify that where there is uncertainty about whether a failure to meet the standards is a technological failure, EPA may presume that it was. Note that this does not mean that EPA might declare any failure to meet standards as a technological failure. It would only apply where it is not clear.

(5) In-Use Testing

EPA and manufacturers have gained substantial experience with in-use testing over the last four or five years. This has led to important insights in ways that the test protocol can be adjusted to be more effective. EPA is accordingly proposing to make the following changes to the regulations in 40 CFR part 86, subparts N and T:

- Revise the NTE exclusion based on aftertreatment temperature to associate the exclusion with the specific aftertreatment device that does not meet the temperature criterion. For example, there should be no NO_X exclusion if a diesel oxidation catalyst is below the temperature threshold. EPA is also proposing to revise the exclusion to include accommodation of CO emissions when there is a problem with low temperatures in the exhaust.

- Clarify that exhaust temperatures should be measured continuously to evaluate whether those temperatures stay above the 250 °C threshold.
- Add specifications to describe where to measure temperatures for exhaust systems with multiple aftertreatment devices.
- Include a provision to add 0.00042 g/hp-hr to the PM measurement to account for PM emissions vented to the atmosphere through the crankcase vent.
- Increase the time allowed for submitting quarterly reports from 30 to 45 days after the end of the quarter.

(6) Miscellaneous Amendments to 40 CFR Part 86

As described elsewhere, EPA is proposing to make several changes to 40 CFR part 86. This includes primarily the GHG standards for Class 2b and 3 heavy-duty vehicles in subpart S. EPA is also proposing changes related to hearing procedures, adjustment factors for infrequent regeneration of aftertreatment devices, and the testing program for heavy-duty in-use vehicles.

EPA is proposing to make several minor amendments to 40 CFR part 86, subpart A, including the following:

- Revise 40 CFR 86.1823 to extend the default catalyst thermal reactivity coefficient for Tier 2 vehicles to also apply for Tier 3 vehicles. This change was inadvertently omitted from the recent Tier 3 rulemaking. EPA is also interested in a broader review of the appropriate default value for the catalyst thermal reactivity coefficient. EPA would be interested in reviewing any available data related to this issue. In any case, EPA would plan to revisit this question in the future.
- Establish a minimum maintenance interval of 1500 hours for DEF filters for heavy-duty engines. This reflects the technical capabilities for filter durability and the expected maintenance in the field.
- Remove the idle CO standard from 40 CFR 86.007–11 and 40 CFR 86.008–10. This standard no longer applies, since all engines are now subject to diagnostic requirements instead of the idle CO standard.

EPA is also proposing several amendments to remove obsolete text, update cross references, and streamline redundant regulatory text. For example, paragraph (f)(3) of Appendix I includes a duty cycle for heavy-duty spark-ignition engines that is no longer specified as part of the certification process.

(7) Applying 40 CFR Part 1068 to Heavy-Duty Highway Engines and Vehicles

As part of the Phase 1 standards, EPA applied the exemption and importation provisions from 40 CFR part 1068, subparts C and D, to heavy-duty highway engines and vehicles. EPA also specified that the defect reporting provisions of 40 CFR 1068.501 were optional. In an earlier rulemaking, EPA applied the selective enforcement auditing under 40 CFR part 1068, subpart E (75 FR 22896, April 30, 2010). EPA is proposing in this rule to adopt the rest of 40 CFR part 1068 for heavy-duty highway engines and vehicles, with certain exceptions and special provisions.

40 CFR part 1068 captures a range of compliance provisions that are common across our engine and vehicle programs. These regulatory provisions generally provide the legal framework for implementing a certification-based program. 40 CFR part 1068 works in tandem with the standard-setting part for each type of engine/equipment. This allows EPA to adopt program-specific provisions for emission standards and certification requirements for each type of engine/equipment while taking a uniform approach to the compliance provisions that apply generally.

Many of the provisions in 40 CFR part 1068 were originally written to align with the procedures established in 40 CFR part 85 and part 86. EPA expects the following provisions from 40 CFR part 1068 to not involve a substantive change for heavy-duty highway engines and vehicles:

- Part 1068, subpart A, describes how EPA handles confidential information, how the Administrator may delegate decision-making within the agency, how EPA may enter manufacturers' facilities for inspections, what information manufacturers must submit to EPA, and how EPA may require testing or perform testing. There is also a description of labeling requirements that apply uniformly for different types of engines/equipment.
- The prohibited acts, penalties, injunction provisions, and related requirements of 40 CFR 1068.101 and 1068.125 correspond to what is specified in Clean Air Act sections 203 through 207 (also see section 213(d)).
- 40 CFR 1068.103 describes how a certificate of conformity applies on a model-year basis. With the exception of the stockpiling provisions in paragraph (f), as described below, these provisions generally mirror what already applies for heavy-duty highway engines.
- 40 CFR 1068.115 describes manufacturers' warranty obligations. EPA is proposing to amend this section to more carefully conform to the warranty provisions in Clean Air Act section 207, as described below. Note that EPA also includes a provision identifying the warranty requirements from Clean Air Act section 203(a)(4), which are specific to motor vehicles.
- 40 CFR 1068.120 describes requirements that apply for rebuilding engines. This includes more detailed provisions describing how the rebuild requirements apply for cases involving a used engine to replace a certified engine.
- 40 CFR part 1068, subpart F, describes procedural requirements for voluntary and mandatory recalls. As noted below, EPA is proposing to modify these regulations to eliminate a few instances where the part 1068 provisions differ from what is specified in 40 CFR part 86, subpart S.
- 40 CFR part 1068, subpart G, describes how EPA would hold a hearing to consider a manufacturer's appeal of an adverse compliance decision from EPA. These procedures apply for penalties associated with violations of the prohibited acts, recall, nonconformance penalties, and generally for decisions related to certification. As noted below, EPA is proposing to migrate these procedures from 40 CFR part 86, including an effort to align with EPA-wide regulations that apply in the case of a formal hearing.

Manufacturers are already required to use good engineering judgment in many cases related to certifying engines under 40 CFR part 86 (see 40 CFR 1068.5).

As noted above, the exemption provisions of 40 CFR part 1068, subpart C, already apply for heavy-duty highway engines. EPA is proposing to add a clarification that the exemption from the tampering prohibition for competition purposes does not apply to heavy-duty highway vehicles. This aligns with the statutory provisions for the racing exemption.

EPA is proposing to require that manufacturers comply with the defect-reporting provisions in 40 CFR 1068.501. Defect reporting under 40 CFR 1068.501 involves a more detailed approach for manufacturers to track possible defects and establishes thresholds to define when manufacturers must perform an investigation to determine an actual rate of emission-related defects. These thresholds are scaled according to production volumes, which allows us to adopt a uniform protocol for everything from locomotives to lawn and garden equipment. Manufacturers that also produce nonroad engines have already been following this protocol for several years. These defect-reporting requirements are also similar to the rules that apply in California.

40 CFR part 1068 includes a definition of ''engine'' to clarify that an engine becomes subject to certification requirements when a crankshaft is installed in an engine block. At that point, a manufacturer may not ship the engine unless it is covered by a certificate of conformity or an exemption. Most manufacturers have opted into this definition of ''engine'' as part of the replacement engine exemption as specified in 40 CFR 85.1714. We are proposing to make this mandatory for all manufacturers. A related provision is the definition of ''date of manufacture'', which we use to establish that an engine's model year is also based on the date of crankshaft installation. To address the concern that engine manufacturers would install a large number of crankshafts before new emission standards start to apply as a means of circumventing those standards, we state in 40 CFR 1068.103(f) that manufacturers must follow their normal production plans and schedules for building engines in anticipation of new emission standards. In addition to that broad principle, we state that we will consider engines to be subject to the standards for the new model year if engine assembly is not complete within 30 days after the end of the model year with the less stringent standards (a longer time frame applies for engines with per-cylinder displacement above 2.5 liters).

40 CFR part 1068 also includes provisions related to vehicle manufacturers that install certified engines. EPA states in 40 CFR 1068.105(b) that vehicle manufacturers are in violation of the tampering prohibition if they do not follow the engine manufacturers' emission-related installation instructions, we approve as part of the certification process.

40 CFR part 1068 also establishes that vehicles have a model year and that installing certified engines includes a requirement that the engine be certified to emission standards corresponding to the vehicle's model year. An exception to allow for normal production and build schedules is described in 40 CFR 1068.105(a). This ''normal-inventory'' allowance is intended to allow for installation of previous-tier engines that are produced under a valid certificate by the engine manufacturer shortly before the new emission standards start to apply. Stockpiling such engines would be considered an unlawful circumvention of the new emission standards. The range of companies and production practices is much narrower for heavy-duty highway engines and vehicles than for nonroad engines and equipment. EPA is therefore proposing a further set of specifications to define or constrain engine-installation schedules that would be considered to fall within normal-inventory practices. In particular, vehicle manufacturers are limited to three months of production, once new emission standards start to apply, to install previous-tier engines without EPA approval. For any subsequent installation of previous-tier engines, EPA is proposing to require that vehicle manufacturers get EPA approval based on a demonstration that the excess inventory was a result of unforeseeable circumstances rather than circumvention of emission standards. EPA is proposing that approval in those circumstances would be limited to a maximum of 50 engines to be installed for up to three additional months for a single vehicle manufacturer.

The existing prohibitions and exemptions in 40 CFR part 1068 related to competition engines and vehicles need to be amended to account for differing policies for nonroad and motor vehicle applications. In particular, we generally consider nonroad engines and vehicles to be ''used solely for competition'' based on usage characteristics. This allows EPA to set up an administrative process to approve competition exemptions, and to create an exemption from the tampering prohibition for products that are modified for competition purposes. There is no comparable allowance for motor vehicles. A motor vehicle qualifies for a competition exclusion based on the physical characteristics of the vehicle, not on its use. Also, if a motor vehicle is covered by a certificate of conformity at any point, there is no exemption from the tampering and defeat-device prohibitions that would allow for converting the engine or vehicle for competition use. There is no prohibition against actual use of certified motor vehicles or motor vehicle engines for competition purposes; however, it is not permissible to remove a motor vehicle or motor vehicle engine from its certified configuration regardless of the purpose for doing so.

It is relatively straightforward to apply the provisions of 40 CFR part 1068 to all engines subject to the criteria emission standards in 40 CFR part 86, subpart A, and the associated vehicles. Manufacturers of comparable nonroad engines are already subject to all these provisions. Class 2b and 3 heavy-duty vehicles subject to criteria emission standards under 40 CFR part 86, subpart S, are covered by a somewhat different compliance program. EPA is therefore proposing to apply the provisions of 40 CFR part 1068 only as described in the next section for light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, and chassis-certified Class 2b and 3 heavy-duty vehicles.

B. Amendments Affecting Gliders and Glider Kits

As noted in Sections III, and V the agencies are proposing not to exempt glider kits from the Phase 2 GHG emission and fuel consumption standards.[877] Gliders and glider kits are exempt from NHTSA's Phase 1 fuel consumption standards. The EPA Phase 1 rules exempted gliders and glider kits produced by small businesses from CO_2 standards (see 40 CFR 1037.150(c)) but did not include such a blanket exemption for other gliders and glider kits. EPA is proposing to amend its rules applicable to engines installed in glider kits, a proposal which would affect emission standards not only for GHGs but for criteria pollutants as well. NHTSA is also considering including gliders under its Phase 2 standards. Finally, EPA believes glider manufacturers may not understand how existing EPA regulations apply to them or otherwise are not complying with existing requirements, resulting in a number of uncertified vehicles. Therefore, EPA is also proposing to clarify its requirements for certification and to revise its definitions for glider manufacturers as described below.

It is important to emphasize that EPA is not proposing to ban gliders. Rather, as is described below, EPA proposing to restrict the number of gliders that may be produced using engines not meeting current standards.

EPA requests comment on its proposed amendments and clarifications regarding gliders. Commenters are encouraged to include technological information and production data for the current glider market, as well as for past practices. Commenters opposing the proposed provisions are also encouraged to suggest alternate approaches that would prevent glider kits from being used to

[877] Glider vehicles are motor vehicles produced to accept rebuilt engines (or other used engines) along with used axles and/or transmissions. The common commercial term ''glider kit'' is used here primarily to refer to a chassis into which the used/rebuilt engine is installed.

circumvent the current emission standards.

(1) Background Under the Clean Air Act

EPA notes that under the anti-tampering provisions of the Clean Air Act, and under EPA's regulatory requirements applicable to rebuilding engines (see 40 CFR 86.004–40), rebuilt engines must continue to comply with emission standards applicable to the model year for which they were originally certified. These regulations specifically apply to rebuilt engines independent of the vehicle into which they are installed or reinstalled. As a general matter, EPA has considered the question of whether the vehicle into which the rebuilt engine is installed is a ''new motor vehicle'' separately from the status of the engine. The use of a rebuilt or other previously used engine in an otherwise newly manufactured vehicle (such as a glider kit) does not keep the vehicle from being ''new'' under the Clean Air Act. (Or, phrased positively, a newly manufactured vehicle remains ''new'' even if a rebuilt engine is installed in it.) This issue became of increased practical import with the advent of separate vehicle (*i.e.* non-engine) standards for GHGs in the Phase 1 rule. Thus, before MY 2014, EPA did not have separate standards for vehicles over 14,000 lbs GVWR. However, EPA Phase 1 GHG vehicle standards apply for new MY 2014 and later vehicles over 14,000 lbs. Thus, EPA generally considers glider kits to be subject to the Phase 1 vehicle standards, and to have been subject to them from the advent of the Phase 1 program.

However, with respect to engines installed in glider kits, an EPA Phase 1 provision in 40 CFR 1037.150(j) provided an exception allowing the use of used or rebuilt engines [878] that were certified to model year 2013 or earlier (or model year 2015 or earlier for spark ignition engines). The effect of this transition provision during Phase 1 was to allow glider kits to use engines not certified to meet the engine GHG or fuel consumption standards, although the glider kits were still required to have an EPA *vehicle* certificate with respect to GHG emissions. In addition, another provision of Phase 1 in 40 CFR 1037.150(c) exempted gliders and glider kits produced by small businesses from the need to obtain a vehicle certificate, but did not include such a blanket exemption for non-small business gliders and glider kits. Thus, depending on the size of the business producing the glider kit, gliders and glider kits may currently be subject to the requirement to obtain a vehicle certificate prior to introduction into commerce as a new vehicle.

(2) Proposed Amendment to EPA Vehicle Standards

EPA is proposing to end both 40 CFR 1037.150 provisions. EPA's proposed program would generally treat glider vehicles the same as other new vehicles. As a result, glider vehicles would have to be certified to the Phase 2 vehicle standards, which (among other things) would require a fuel map for the actual engine in order to run GEM. In other words, manufacturers producing glider kits would need to meet the applicable GHG vehicle standards and, as part of its compliance demonstration, would need to have a fuel map for each engine that would be used.

EPA is proposing this provision because we believe there has been adequate time for glider manufacturers to transition to a compliance regime. Moreover, as noted more fully below, with increased numbers of glider kits being produced, perpetuation of the interim exemption from Phase 1 would turn a transition provision into an on-going loophole. Nevertheless, EPA is proposing to replace this provision with a limited allowance for small business manufacturers as described in the proposed 40 CFR 1037.635. EPA is also proposing new definitions of ''glider vehicle'' and ''glider kit'' in 40 CFR 1037.801 that are generally consistent with the common understanding of these terms as meaning new chassis with a used engine or designed to accept a used engine.

(3) Proposed Change to EPA Engine Standards

EPA is also proposing to amend its rules to require that engines used in glider vehicles must be certified to the standards applicable to the calendar year in which assembly of the glider vehicle is completed. This requirement would apply to all pollutants, and thus would encompass criteria pollutant standards as well as GHG standards. Used or rebuilt engines could be used, as long as they had been certified to the same standards as apply for the calendar year of glider vehicle assembly. For example, if assembly of a glider vehicle was completed in calendar year 2020, the engine standards applicable to MY 2020 engines would have to be satisfied. (If the engine standards for model year 2020 were the same as for model years 2017 through 2019, then any model year 2017 or later engine could be used.)

EPA is proposing to amend these rules because, with the advent in MY 2007 of more stringent HD diesel engine criteria pollutant standards, continuation of provisions allowing rebuilt and reused engines to meet earlier MY criteria pollutant standards results in unnecessarily high in-use emissions. GHG emissions from these engines also are controllable. As more glider kits are produced, EPA believes that these emissions should be controlled to the same levels as other new engines.

Since EPA has already justified the criteria pollutant emission standards for heavy duty diesel engines pursuant to CAA section 202 (a)(3)(C), it is not clear that any further justification for applying those standards to engines used in glider kits is needed. The GHG engine standards for Phase 1 have likewise already been justified, and the proposed Phase 2 engine standards' justification is set out in Section II above. If any further justification is required, EPA notes that the emission benefits of applying current criteria pollutant standards would be substantial, and at low cost. Glider vehicle production is not being reported to EPA, and we cannot determine precisely how much of an emission impact these vehicles are having. Nevertheless, since the current standards for NO_X and PM are at least 90 percent lower than the most stringent previously applicable standards, we can be certain that the NO_X and PM emissions of any glider vehicles using pre-2007 engines are at least ten times as high as emissions from equivalent vehicles being produced with brand new engines.[879] Thus, each glider vehicle that is purchased instead of a new vehicle with a current MY engine results in significantly higher in-use emissions. EPA recognizes that the environmental impacts of gliders using 2010 and later engines would be much smaller, and requests comment on whether we should treat such gliders differently than gliders using older engines.

These emission impacts are being compounded by the increasing sales of these vehicles. Estimates provided to EPA indicate that production of glider vehicles has increased by an order of magnitude from what it was in the 2004–2006 time frame—from a few

[878] Most glider vehicles being produced today are assembled with rebuilt engines. However, it is also possible to use previously used engines that are not rebuilt.

[879] The NO_X and PM standards for MY 2007 and later engines are 0.20 g/hp-hr and 0.01 g/hp-hr, respectively. The standards for MY 2004 through 2006 engines were ten times these levels, and earlier standards were even higher.

hundred each year to thousands.[880] While the few hundred glider vehicles produced annually in the 2004–2006 timeframe may have been produced for arguably legitimate purposes such as salvaging powertrains from vehicles otherwise destroyed in accidents, EPA believes the tenfold increase in glider kit production since the MY 2007 criteria pollutant emission standards took effect reflects an attempt to circumvent these more stringent standards and (ultimately) the Clean Air Act.

The cost for manufacturers to comply with the vehicle-based GHG standards is similar for gliders as for other new vehicles. Similar to EPA's analysis of emissions above, although we cannot precisely quantify the cost of complying with the proposed engine requirements for criteria pollutant standards because it is dependent on which engines would be used and which would have otherwise been used, EPA nevertheless believes that cost-effectiveness (dollars per ton) of the proposed requirement relative to any pre-2007 engine would be similar to the cost-effectiveness of the NO_X and PM standards for current model year engines, which EPA has already found to be cost effective.

The agencies (as well as the broader SBAR Panel) are, however, concerned about adverse economic impacts on small businesses that assemble gliders and build glider kits, and we recognize that production of a smaller number of gliders by these small manufacturers may be appropriate for salvaged engines or other non-circumvention purposes. Therefore, EPA is proposing a new provision that would preserve its regulatory status quo for existing small businesses, but cap annual production based on recent sales. Thus, a limited number of glider kits produced by small businesses would not have to meet the GHG vehicle standards, and could use rebuilt or used engines provided those engines were certified to the year of the engine's manufacture. For example, an existing small business that produced between 100 and 200 glider vehicles per year would be allowed to produce up to 200 glider vehicles per year under without having to certify them to the GHG standards, or re-certifying the engines to the now-applicable EPA standards for criteria pollutants and GHGs (so long as the engine is certified to criteria pollutant standards for the year of its manufacture). To be eligible for this provision, EPA is also proposing that no small entity could produce more than 300 glider vehicles in any given model year without certifying (or recertifying) to any EPA standards. EPA believes that this level reflects the upper end of the range of production that occurred before significant circumvention of the 2007 criteria pollutant standards began. We request comment on the appropriate caps (including the appropriate magnitude of the caps) and on whether any other special provisions would be needed to accommodate glider kits. EPA also requests comment on whether we should allow larger manufacturers to produce some limited number of glider kits.

(4) Lead Time for Amended Standards

EPA is proposing that this requirement for gliders to meet engine and vehicle standards applicable to other new vehicles and engines take effect on January 1, 2018. EPA believes this provides sufficient time to ''permit the development and application of the requisite control measures'' (CAA section 202 (a)(3)(D)) because compliant engines are available today, although manufacturers would need several months to change business practices to comply. EPA also solicits comment on whether an earlier or later compliance date would be appropriate. We also request comment on whether we should include a production limit if we provide additional lead time in the Final Rule.

(5) Legal Authority and Definitions Under the Clean Air Act

With respect to statutory authority under the Clean Air Act, EPA notes first that it has broad authority to control all pollutant emissions from ''any'' rebuilt heavy duty engines (including engines beyond their statutory useful life). See CAA section 202(a)(3)(D). EPA is to give ''appropriate'' consideration to issues of cost, energy, and safety in developing such standards, and to provide necessary lead time to implement those standards. As noted above, if a used engine is placed in a glider kit, the engine would be considered a ''new motor vehicle engine'' because it is being used in a new motor vehicle (as explained in the following paragraph). See CAA section 216(3). With respect to the vehicle-based GHG standards, there is no question that the completed glider is a ''motor vehicle'' under the Clean Air Act (as well as under NHTSA's safety provisions). Some in the trucking industry have questioned whether a glider kit (without an engine) is a motor vehicle. However, EPA considers glider kits to be incomplete motor vehicles, and EPA has the authority to regulate incomplete motor vehicles, including unmotorized chassis.

Under the CAA, it is also important that ''new'' is determined based on legal title and does not consider prior use. Thus, glider kits that have a new vehicle identification number (VIN) and new title are considered to be ''new motor vehicles'' even if they incorporate previously used components. Note that under the Clean Air Act, EPA would not consider the fact that a vehicle retained the VIN of the donor vehicle from which the engine was obtained determinative of whether or not the vehicle is new.

The CAA also defines ''manufacturer'' to include any person who assembles new motor vehicles. EPA is proposing to revise its regulatory definitions of these terms in 40 CFR 1036.801 and 1037.801 to more clearly reflect these aspects of the CAA definitions—that glider kits are ''new motor vehicles'', previously used engines (whether rebuilt or not) installed into glider kits are ''new motor vehicle engines'', and any person who completes assembly of a glider is a ''manufacturer''. EPA also notes that under the existing 40 CFR 1037.620, glider kit assemblers would generally be considered to be secondary vehicle manufacturers. That section, which EPA is proposing to redesignate as 40 CFR 1037.622, allows secondary vehicle manufacturers that have a valid certificate or exemption to receive incomplete vehicles (such as glider kits) from OEMs.

To further clarify that EPA considers both glider kits and completed glider vehicles to be motor vehicles, EPA is proposing to add a clarification to our definition of ''motor vehicle'' in 40 CFR 85.1703 regarding vehicles such as gliders that clearly are intended for use on highways, consistent with the CAA definition of ''motor vehicle'' in CAA section 216 (2). The regulatory definition presently contains a provision stating that vehicles lacking certain safety features required by state or federal law are not ''motor vehicles''. This caveat needs a proper context: Is the safety feature one that would prevent operation on highways. If not, absence of that feature does not result in the vehicle being other than a motor vehicle. The proposed amendment would consequently make clear that vehicles that are clearly intended for operation on highways are motor vehicles, even if they do not have every safety feature. (EPA is also considering whether to simply eliminate the clause ''or safety features required by state and/or federal law'' from the regulatory definition.) This clarifying provision would take effect upon promulgation.

[880] ''Industry Characterization of Heavy Duty Glider Kits'', MacKay & Company, September 30, 2013.

We note that NHTSA and EPA have separate definitions for motor vehicles under their separate statutory authorities. As such, EPA's determination of how its statute and regulations apply to glider kits and glider vehicles has no bearing on how NHTSA may apply its safety authority with regard to them. See Section XIV. B. (6) for additional discussion of NHTSA's consideration of glider vehicles.

(6) Relation to NHTSA Fuel Efficiency Program and Safety Regulations

NHTSA does not consider glider kits to be motor vehicles, but it does consider assembled glider vehicles to be motor vehicles. As stated above, NHTSA is considering including glider vehicles under its Phase 2 standards. NHTSA seeks comments from glider manufacturers on this consideration.

We believe that the agencies potentially having different policies for glider kits and glider vehicles under the Phase 2 program would not result in problematic disharmony between the NHTSA and EPA programs, because of the small number of vehicles that would be involved. EPA believes that its proposed changes would result in the glider market returning to the pre-2007 levels, in which fewer than 1,000 glider vehicles would be produced in most years. Given that a large fraction of these vehicles would be exempted from EPA regulations because they would be produced by qualifying small businesses, they would thus, in practice, be treated the same under EPA and NHTSA regulations. Only non-exempt glider vehicles would be subject to different requirements under the NHTSA and EPA regulations. However, we believe that this is unlikely to exceed a few hundred vehicles in any year, which would be few enough not to result in any meaningful disharmony between the two agencies.

With regard to NHTSA's safety authority over gliders, the agency notes that it has become increasingly aware of potential noncompliances with its regulations applicable to gliders. NHTSA has learned of manufacturers who are creating glider vehicles that are new vehicles under 49 CFR 571.7(e), however, the manufacturers are not certifying them and obtaining a new VIN as required. NHTSA plans to pursue enforcement actions as applicable against noncompliant manufacturers. In addition to enforcement actions, NHTSA may consider amending 49 CFR 571.7(e) and related regulations as necessary. NHTSA believes manufacturers may not be using this regulation as originally intended.

C. Applying the General Compliance Provisions of 40 CFR Part 1068 to Light-Duty Vehicles, Light-Duty Trucks, Chassis-Certified Class 2B and 3 Heavy-Duty Vehicles and Highway Motorcycles

As described above, EPA is proposing to apply all the general compliance provisions of 40 CFR part 1068 to heavy-duty engines and vehicles. EPA proposes to also apply the recall provisions and the hearing procedures from 40 CFR part 1068 for highway motorcycles and for all vehicles subject to standards under 40 CFR part 86, subpart S. See the preceding section for a description of how the provisions from 40 CFR part 1068 compare to those in 40 CFR part 85 and part 86.

EPA also requests comment on applying the rest of the provisions from 40 CFR part 1068 to highway motorcycles and to all vehicles subject to standards under 40 CFR part 86, subpart S. EPA particularly requests comment on applying the defect-reporting provisions in 40 CFR 1068.501 to these vehicles. The general approach is to replace a fixed threshold of 25 defects as the basis for defect reporting with a scaled approach that would require defect reporting only after the manufacturer finds some larger number of actual emission-related defects. The regulation calls for manufacturers to monitor possible emission-related defects as evidenced by warranty claims, in-use testing, and other indicators, and to start investigating for actual defects once possible defects exceed an established threshold. The existing regulation in 40 CFR 1068.501 generally calls for investigating once possible defects exceed 5 to 10 percent of production, with a requirement to report defects if confirmed defects exceed a rate of 1 to 2 percent of production. The percentage thresholds that apply for a given engine/vehicle model decrease with increasing production volumes. This approach is similar to defect-reporting requirements that already apply in California. Manufacturers may be interested in complying with a single set of defect-reporting provisions nationwide; EPA therefore also requests comment on simply requiring manufacturers to follow the California defect-reporting scheme for their EPA-certified vehicles.

Note that EPA is proposing to amend 40 CFR 85.1701 to specify that the exemption provisions apply to heavy-duty engines subject to regulation under 40 CFR part 86, subpart A. This is intended to limit the scope of this provision so that it does not apply for Class 2b and 3 heavy-duty vehicles subject to standards under 40 CFR part 86, subpart S. This change corrects and inadvertently broad reference to heavy-duty vehicles in 40 CFR 85.1701.

D. Amendments to General Compliance Provisions in 40 CFR Part 1068

The general compliance provisions in 40 CFR part 1068 apply broadly too many different types of engines and equipment. This section describes how EPA is proposing to amend these procedures to make various corrections and adjustments.

(1) Hearing Procedures

EPA is proposing to update and consolidate its regulations related to formal and informal hearings in 40 CFR part 1068, subpart G. This will allow us to rely on a single set of regulations for all the different categories of vehicles, engines, and equipment that are subject to emission standards. EPA also made an effort to write these regulations for improved readability.

The hearing procedures specified in 40 CFR part 1068 apply to the various categories of nonroad engines and equipment (along with the other provisions of part 1068). EPA is proposing in these rules to apply these hearing procedures also to heavy-duty highway engines, light-duty motor vehicles, and highway motorcycles. EPA believes there is no reason to treat any of these sectors differently regarding hearing procedures.

EPA is proposing an introductory section that provides an overview of requesting a hearing for all cases where a person or a company objects to an adverse decision by the agency. In certain circumstances, as spelled out in the regulations, a person or a company can request a hearing before a Presiding Officer. Statutory provisions require formal hearing procedures for administrative enforcement actions seeking civil penalties. The Clean Air Act does not require a formal hearing for other agency decisions; EPA is therefore proposing to specify that informal hearing procedures apply for all such decisions.

The introductory section also adds detailed provisions describing the requirements for submitting information to the agency in a timely manner. These provisions accommodate current practices for electronic submission, distinguish between postal and courier delivery and provide separate requirements for shipments made from inside and outside the United States. The specified deadlines are generally based on the traditional approach of a postmark determining whether a submission is timely or not. Fax, email and courier shipments are similarly specified as needing to be sent by close of business on the day of the deadline. A different approach applies for shipments originating from outside the United States. Because time in transit can vary dramatically, we are proposing to specify that foreign shipments need to be received in our office by the specified deadline to be considered timely. Given the option to send documents by email or by fax, EPA expects this approach would not pose any disadvantage to anyone making an appeal from outside the United States.

EPA is proposing to replace the current reference to 40 CFR 86.1853–01 for informal hearings with a full-text approach that captures this same material. EPA attempted to write these proposed regulations in a way that would not change the underlying hearing protocol.

The regulations currently reference the formal hearing procedures in 40 CFR 85.1807, which were originally drafted to apply to light-duty motor vehicles. After we adopted the hearing procedures in 40 CFR 85.1807, EPA's Office of Administrative Law Judges finalized a set of regulations defining formal hearing procedures that were intended to apply broadly across the agency for appeals under every applicable statute. *See* 40 CFR part 22, ''Consolidated Rules of Practice Governing the Administrative Assessment of Civil Penalties and the Revocation/Termination or Suspension of Permits.'' EPA is therefore revising the regulations in 40 CFR part 1068 to simply refer to these formal hearing procedures in 40 CFR part 22.

(2) Additional Changes to General Compliance Provisions

EPA is also proposing to make numerous changes across 40 CFR part 1068 to correct errors, to add clarification, and to make adjustments based on lessons learned from implementing these regulatory provisions. This includes the following proposed changes:

- § 1068.1: Clarify applicability of part 1068 with respect to legacy parts (such as 40 CFR parts 89 through 94).
- § 1068.20: Clarify that EPA's inspection activities do not depend on having a warrant or a court order. As noted in the standard-setting parts, EPA may deny certification or suspend or revoke certificates if a manufacturer denies EPA entry for an attempted inspection or other entry.
- § 1068.27: Clarify that EPA confirmatory testing may properly be performed before issuance of a certificate of conformity. We are also making an addition to state that we may require manufacturers to give us any special components that are needed for EPA testing.
- § 1068.30: Add definitions of ''affiliated companies'', ''parent company'', and ''subsidiaries'' to clarify how small-business provisions apply for a range of business relationships.
- § 1068.30: Clarify that a manufacturer can be considered a certificate holder based on the current or previous model year (to avoid problems from having a gap between model years).
- § 1068.30: Spell out contact information for the ''Designated Compliance Officer'' to clarify how manufacturers should submit information to the agency. This includes email addresses for the various sectors.
- § 1068.32: Add discussion to establish the meaning of various terms and phrases for EPA regulations; for example, we distinguish between standards, requirements, allowances, prohibitions, and provisions. EPA is also clarifying terminology with respect to singular/plural, inclusive lists, notes and examples in the regulatory text, and references to ''general'' or ''typical'' circumstances. EPA also describes some of the approach to determining when ''unusual circumstances'' apply.
- § 1068.45: Allow manufacturers to use coded dates on engine labels; allow EPA to require the manufacturer to share information to read the coded information.
- § 1068.45: Clarify that engine labels are information submissions to EPA.
- §§ 1068.101 and 1068.125: Update penalty amounts to reflect changes to 40 CFR part 19.
- § 1068.101: Revise the penalty associated with the tampering prohibition to be an engine-based penalty, as opposed to assessing penalties per day of engine operation. This correction aligns with Clean Air Act section 205.
- § 1068.103: Clarify the process for reinstating certificates after suspending, revoking, or voiding.
- § 1068.103: Clarify that the prohibition against ''offering for sale'' uncertified engines applies only for engines already produced. It is not a violation to invite customers to buy engines as part of an effort to establish the economic viability of producing engines, as would be expected for market research.
- § 1068.105: Require documentation related to ''normal inventory'' for stockpiling provision. EPA is also clarifying that there is no specific deadline associated with producing ''normal-inventory'' engines under this section, but emphasizing that vehicle/equipment manufacturers may not delay engine installation beyond their normal production schedules. EPA is also clarifying that the allowance related to building vehicles/equipment in the early part of a model year, before the start of a new calendar year corresponding to new emission standards, applies only in cases where vehicle/equipment assembly is complete before the start of the new calendar year. This is intended to prevent manufacturers from circumventing new standards by initiating production of large numbers of vehicles/equipment for eventual completion after new standards have started to apply.
- § 1068.115: Clarify warranty provisions to align with statute.
- § 1068.120: Describe how the rebuilding provisions apply in the case of engine replacements where the new and old engines are subject to standards under different standard-setting parts (such as switching from spark-ignition to compression-ignition nonroad engines).
- § 1068.201: Describe how someone may sell an engine under a different exemption than was originally intended or used.
- § 1068.210: Remove the requirement for companies getting approval for a testing exemption to send us written confirmation that they meet the terms and conditions of the exemption. We do not believe this submission is necessary for implementing the testing exemption.
- § 1068.220: Add description of how we might approve engine operation under the display exemption. This is intended to more carefully address circumstances in which engine operation is part of the display function in question. We would want to consider a wide range of factors in considering such a request; for example, we could be more inclined to approve a request for a display exemption if the extent of operation is very limited, or if the engine/equipment has emission rates that are comparable to what would apply absent the exemption. EPA is also removing the specific prohibition against generating revenue with exempted engines/equipment, since this has an unclear meaning and we can take any possible revenue generation into account in considering whether to approve the exemption on its merits.
- § 1068.230: Add provision allowing for engine operation under the export exemption only as needed to prepare it for export (this has already been in

place in part 85, and in part 1068 for engines/equipment imported for export).

- § 1068.235: Clarify that the standard-setting part may set conditions on an exemption for competition engines/equipment.
- § 1068.240: Describe the logistics for identifying the disposition of engines being replaced under the replacement engine exemption. In particular, manufacturers would need to identify the disposition of each engine by the due date for the report under § 1068.240(c) to avoid counting them toward the production limit for untracked replacement engines. We are proposing to delay the due date for the report until September 30 following the production year to allow more time for manufacturers to make these determinations.
- § 1068.240: Clarify the relationship between paragraphs (d) and (e).
- § 1068.250: Simplify the deadline for requesting small-volume hardship.
- § 1068.255: Clarify that hardship provisions for equipment manufacturers are not limited to small businesses, and that a hardship approval is generally limited to a single instance of producing exempt equipment for up to 12 months.
- § 1068.260: State that manufacturers shipping engines without certain emission-related components need to identify the unshipped components either with a performance specification (where applicable) or with specific part numbers. We are also listing exhaust piping before and after aftertreatment devices as not being emission-related components for purposes of shipping engines in a certified configuration.
- §§ 1068.260 and 1068.262: Revise the text to clarify that provisions related to partially complete engines have limited applicability in the case of equipment subject to equipment-based exhaust emission standards (such as recreational vehicles). These provisions are not intended to prevent the sale of partially complete equipment with respect to evaporative emission standards. We intend to address this in the future by changing the regulation in 40 CFR part 1060 to address this more carefully.
- § 1068.262: Revise text to align with the terminology and description adopted for similar circumstances related to shipment of incomplete heavy-duty vehicles under 40 CFR part 1037.
- § 1068.301: Revise text to more broadly describe importers' responsibility to submit information and store records and explicitly allow electronic submission of EPA declaration forms and other importation documents.
- § 1068.305: Remove the provision specifying that individuals may need to submit taxpayer identification numbers as part of a request for an exemption or exclusion for imported engines/equipment. We do not believe this information is necessary for implementing the exemption and exclusion provisions.
- § 1068.315: Allow for destroying engines/equipment instead of exporting them under the exemption for importing engines/equipment for repairs or alterations.
- § 1068.315: Remove the time constraints on approving extensions to a display exemption for imported engines/equipment. EPA would continue to expect the default time frame of one year to be appropriate, and extension of one to three years is sufficient for most cases; however, we are aware that there are occasional circumstances calling for a longer-term exemption. For example, an engine on display in a museum might appropriately be exempted indefinitely once its place in a standing exhibition is well established.
- § 1068.315: Specify that engines under the ancient engine exemption must be *substantially* in the original configuration.
- § 1068.360: Clarify the provisions related to model year for imported products by removing a circularity regarding ''new'' engines and ''new'' equipment.
- § 1068.401: Add explicit statement that SEA testing is at manufacturer's expense. This is consistent with current practice and the rest of the regulatory text.
- § 1068.401: Allow for requiring manufacturers other than the certificate holder to perform selective enforcement audits in cases where multiple manufacturers are cooperatively producing certified engines.
- § 1068.401: State that SEA non-cooperation may lead to suspended or revoked certificate (like production-line testing).
- § 1068.415: Set up new criteria for lower SEA testing rate based on engine power to allow for a reduced testing rate of one engine per day only for engines with maximum engine power above 560 kW, but keep the allowance to approve a lower testing rate; that may be needed, for example, if engine break-in (stabilization) and testing are performed on the same dynamometer. EPA believes it is more appropriate to base reduced testing rates on engine characteristics rather than sales volumes, as has been done in the past.
- § 1068.415: Revise the service accumulation requirement to specify a maximum of eight days for stabilizing a test engine. This is necessary to address a situation where an engine operates only six hours per day to achieve stabilization after well over 50 hours. For such cases, we would expect manufacturers to be able to run engines much more than six hours per day. As with testing rates, manufacturers may ask for our approval to use a longer stabilization period if circumstances don't allow them to meet the specified service accumulation targets.
- § 1068.501, and Appendix I: Clarify that ''emission-related components'' include components whose failure *would commonly* increase emissions (not might increase), and whose *primary* purpose is to reduce emissions (not sole purpose); current regulations are not consistent.
- § 1068.501: Add ''in-use testing'' to list of things to consider for investigating potential defects.
- § 1068.505: Clarify that manufacturers subject to a mandatory recall must remedy noncompliant target vehicles without regard to their age or mileage at the time of repair, consistent with provisions that already apply under 40 CFR part 85.
- § 1068.505: Revise the requirement for submitting a remedial report from a 60-day maximum to a 45-day minimum (or 30-day minimum in the event of a hearing). This adjusted approach already applies to motor vehicles under 40 CFR part 85.
- § 1068.515: Clarify an ambiguity to require that manufacturers identify the facility where repairs or inspections are performed.
- § 1068.530: Specify that recall records must be kept for five years, rather than three years. This is consistent with longstanding recall policy for motor vehicles and motor vehicle engines under 40 CFR part 85.

Manufacturers and equipment operators have raised an additional question about how the regulations apply for replacement engines where the replacement engine is of a different type than the engine being replaced. For example, someone operating a piece of industrial equipment may want to replace an old spark-ignition engine with a compression-ignition engine (or vice versa). The replacement engine could be freshly manufactured, or it may have already been placed into service. The tampering prohibition would generally disallow ''disabling emission controls,'' but regulations do not directly address how this applies relative to the multiple emission standards that apply. It is important to note that the standard-setting part often specifies that a used replacement engine becomes new (and subject to certification requirements) if it is installed in a piece of equipment from a different category. For example, installing a used heavy-duty highway engine in land-based nonroad equipment would make the engine ''new'' and subject to certification requirements as a nonroad engine. This does not apply for spark-ignition engines and compression-ignition engines installed in heavy-duty highway vehicles, or for spark-ignition engines and compression-ignition engines installed in land-based nonroad equipment. We request comment on the best approach to delineating how the tampering prohibition should apply for these scenarios.

E. Amendments to Light-Duty Greenhouse Gas Program Requirements

EPA is proposing to make minor changes to correct errors and clarify regulations in 40 CFR part 86, subpart S, and 40 CFR part 600 relating to EPA's light-duty greenhouse gas emission standards. This includes the following proposed changes:

- § 86.1818–12: Correct a reference in paragraph (c)(4) and clarify that CO_2-equivalent debits for N_2O and CH_4 are calculated in Megagrams and rounded to the nearest whole Megagram.
- § 86.1838–01: Correct references in paragraph (d)(3)(iii).
- § 86.1866–12: Correct a reference in paragraph (b).
- § 86.1868–12: Clarify language in the introductory paragraph explaining the model years of applicability of different provisions for air conditioning efficiency credits. In paragraph (e)(5) clarify that the engine-off specification of 2 minutes is intended to be cumulative time. In paragraphs (f)(1), (g)(1), and (g)(3), clarify language by pointing to the definitions in § 86.1803–01.
- § 86.1869–12: Make corrections to the language for readability in paragraph (b)(2). In paragraph (b)(4)(ii) delete the phrase ''backup/reverse lights'' because these lights were not intended to be part of the stated eligibility criteria for high-efficiency lighting credits. Correct references in paragraph (f).
- § 86.1870–12: Add language that clarifies that a manufacturer that meets the minimum production volume thresholds with a combination of mild and strong hybrid electric pickup trucks is eligible for credits.
- § 86.1871–12: Clarify that credits from model years 2010–2015 are not limited to a life of 5 model years. A recent rule extended the life of 2010–2015 credits to model year 2021; thus, language referring to a 5-year life for emission credits generated in these model years is being removed or revised.
- § 600.113–12: Correct language in paragraph (m)(1), which relates to vehicles operating on LPG, that erroneously refers to methanol and methanol-fueled.
- § 600.113–12: Correct references in paragraph (n) and add a new paragraph (m) that reinstates language mistakenly dropped by a previous regulation.
- § 600.116–12: Correct description of physical quantity to refer to ''energy'' rather than ''current'', and correct various paragraph references.
- § 600.208–12: Correct a reference in paragraph (a)(2)(iii).
- § 600.210–12: Correct a reference and text in paragraph (c)(2)(iv)(C).

F. Amendments to Highway and Nonroad Test Procedures and Certification Requirements

(1) Testing With Aftertreatment Devices Involving Infrequent Regeneration

Manufacturers generally rely on selective catalytic reaction and diesel particulate filters to meet EPA's emission standards for highway and nonroad compression-ignition engines. These emission control devices typically involve infrequent regeneration, which can have a significant effect on emission rates. EPA has addressed that for each engine type by provisions for infrequent regeneration factors; this is a calculation methodology that allows manufacturers to incorporate the effect of infrequent regeneration into reported emission values whether or not that regeneration occurs during an emission test. EPA adopted separate provisions for highway, locomotive, marine, and land-based nonroad compression-ignition engines. EPA is proposing to harmonize the common elements of these procedures in 40 CFR part 1065, and to add clarifying specifications in each of the standard-setting parts for sector-specific provisions.

(2) Mapping for Constant-Speed Engines Under 40 CFR Part 1065

EPA is proposing to revise this section as it applies to the two-point mapping method for certain constant-speed engines. The regulations currently cite a performance parameter in ISO 8528–5 that does not apply for the design of these engines.

Common practice for engines that produce electric power is to use an isochronous governor for stand-alone generator sets. In some parallel operations of multiple generator sets, droop is added as a method for load sharing. The amount of droop can be tuned by the generator set manufacturer or the site system integrator. Such engines are commonly tested on an engine dynamometer with the isochronous governor.

Mapping with just two points works well for the case of 0 percent droop (*i.e.* isochronous governor). For this case, a persistent speed error is forced on the engine governor on the second point and this will cause the governor to wind up to its maximum command. The second point is effectively operating on the torque curve instead of the isochronous governor. So, the second point captures the full fueling torque (plus a small amount due to any rising torque curve). This measured torque is used as the maximum test torque for computing the emission test points. Since there is no designed-in droop, some target amount of speed error is needed for the second point. The regulation at 40 CFR 1065.510(d)(5)(iii) currently has a default target speed on the second point of 97.5 percent of the no-load speed measured on the first point. This results in a persistent speed error of 2.5 percent of the no-load speed. For an 1800 rpm no-load speed, this would give a target speed of 1755 rpm and a 45 rpm speed error on an isochronous governor. If the engine has a torque rise of 20 percent from 1800 to 1200 rpm (0.0333 percent torque rise per rpm), this 45 rpm error will cause a 1.5 percent of point error in the determination of the intended maximum test torque. This error is larger than desired for this type of testing. Fortunately, engines and test cells have sufficient speed resolution to select a lower speed error, which reduces this error in maximum test torque. In practice, testing with a speed error at or below 0.5 percent is more than adequate to cause the isochronous governor to wind up to maximum fueling. Using a target speed of 99.5 percent on the second point gives a target speed of 1791 rpm for an 1800 rpm no-load speed and will reduce the error on the maximum test torque to a reasonable 0.3 percent of point for the 20 percent torque rise case described above.

For governors with droop, if we attempt the two-point method, we would have to calculate a target speed for the second point based on a designed amount of droop. Unfortunately, the actual governor may not have the same amount of droop as the design droop, which may cause error in the measured torque versus the maximum test torque associated with a complete torque map. Also, the design droop may be based on a torque value that is different from the intended maximum test torque. Thus, the two-point method is not sufficient to yield a maximum test torque equivalent to the value that would be obtained using a multi-point map. Also the allowed speed error on the second point is 20 percent of the speed droop, which allows an unacceptably large error in the maximum test torque.

Thus, for the reasons listed, we are proposing to limit the two-point mapping method to any isochronous governed engines, not just engines used to generate electric power.

(3) Calculating Maximum and Intermediate Test Speeds Under 40 CFR Part 1065

EPA is proposing to improve the method for calculating maximum and intermediate test speeds by applying a more robust calculation method. The new calculation method would be consistent with the methodology used for the maximum test torque determination, which we revised in our light-duty Tier 3 rulemaking. Under the current regulations, the result is a measured maximum test torque at one of the map points. The proposed calculation method involves interpolation to determine the measured maximum test torque, yielding a more representative maximum test torque lbs.

(4) Additional Test Procedure Amendments

EPA is proposing the following additional changes to test procedures in 40 CFR part 1065 and part 1066:

- § 1065.15: Allow manufacturers to use NMOG measurements to demonstrate compliance with NMHC standards. We also request comment on whether other forms of hydrocarbon standards (such as VOC) should be allowed for alternative fuels.
- § 1066.210: Revise the dynamometer force equation to incorporate grade, consistent with the coastdown procedures being proposed for heavy-duty vehicles. For operation at a level grade, the additional parameters cancel out of the calculation.
- § 1066.605: Adding an equation to the regulations to spell out how to calculate emission rates in grams per mile. This calculation is generally assumed, but we want to include the equation to remove any uncertainty about calculating emission rates from mass emission measurements and driving distance.
- § 1066.815: Create an exception to the maximum value for overall residence time for PM sampling methods that involve PM samples collected for combined bags over a duty cycle. This is needed to accommodate the reduced sample flow rates associated with these procedures.

G. Amendments Related to Nonroad Diesel Engines in 40 CFR Part 1039

EPA is proposing two changes to 40 CFR 1039.5 to clarify the scope and applicability of standards under 40 CFR part 1039. First, EPA is stating that engines using the provisions of 40 CFR 1033.625 for non-locomotive-specific engines remain subject to certification requirements as nonroad diesel engines under 40 CFR part 1039. Such engines would need to be certified as both locomotive engines and as nonroad diesel engines. Second, EPA is proposing to revise the statement about how manufacturers may certify under 40 CFR part 1051 for engines installed in recreational vehicles (such as all-terrain vehicles or snowmobiles). EPA is proposing to remove text that might be interpreted to mean that there are circumstances in which certification under neither part is required. The proper understanding of EPA's policy in that regard is that certification under one part is a necessary condition for being exempted from the other part.

In 2008, EPA adopted a requirement in 40 CFR part 1042 for manufacturers to design marine diesel engines using selective catalytic reduction with basic diagnostic functions to ensure that these systems were working as intended (73 FR 37096, June 30, 2008). EPA is proposing to apply those same diagnostic control requirements to nonroad diesel engines regulated under 40 CFR part 1039. This addresses the same fundamental concern that engines would not be controlling emissions consistent with the certified configuration if the engine is lacking the appropriate quantity and quality of reductant. While some lead time would be needed to make the necessary modifications, we believe it will be straightforward to apply the same designs from marine diesel engines to land-based nonroad diesel engines. EPA is accordingly proposing that manufacturers meet the proposed diagnostic specifications starting with model year 2018. These diagnostic controls would not affect the current policy related to adjustable parameters and inducements related to selective catalytic reduction. EPA requests comment on adding these diagnostic requirements for nonroad diesel engines.

EPA is proposing to make numerous changes across 40 CFR part 1039 to correct errors, to add clarification, and to make adjustments based on lessons learned from implementing these regulatory provisions. This includes the following proposed changes:

- § 1039.2: Add a clarifying note to say that something other than a conventional ''manufacturer'' may need to certify engines that become new after being placed into service (such as engines converted from highway or stationary use). This is intended to address a possible assumption that only conventional manufacturers can certify engines.
- §§ 1039.30, 1039.730, and 1039.825: Consolidate information-collection provisions into a single section.
- § 1039.107: Remove the reference to deterioration factors for evaporative emissions, since there are no deterioration factors for demonstrating compliance with evaporative emission standards.
- § 1039.104(g): Correct the specified FEL cap for an example scenario illustrating how alternate FEL caps work.
- § 1039.120: Reduce extended-warranty requirements to warranties that are actually provided to the consumer, rather than to any published warranties that are offered. The principle is that the emission-related warranty should not be less effective for emission-related items than for items that are not emission-related.
- § 1039.125: Allow for special maintenance procedures that address low-use engines. For example, owners of recreational marine vessels may need to perform engine maintenance after a smaller number of hours than would otherwise apply based on the limited engine operation over time.
- § 1039.125: Establish a minimum maintenance interval of 1500 hours for DEF filters. This reflects the technical capabilities for filter durability and the expected maintenance in the field.
- § 1039.125: Add fuel-water separator cartridges as an example of a maintenance item that is not emission-related.
- § 1039.135: Allow for including optional label content only if the manufacturer does not opt to omit other information based on limited availability of space on the label, and identify counterfeit protection as an additional item that manufacturers may include on the label.
- § 1039.201: Clarify that manufacturers may amend their application for certification after the end of the model year in certain circumstances, but they may not produce engines for a given model year after December 31 of the named year.

• § 1039.201: Establish that manufacturers may deliver to EPA for testing an engine that is identical to the test engine used for certification. This may be necessary if the test engine has accumulated too many hours, or if it is unavailable for any reason.

• § 1039.205: Replace the requirement to submit data from invalid tests with a requirement to simply notify EPA in the application for certification if test was invalidated.

• § 1039.205: Add a requirement for manufacturers to include in their application for certification a description of their practice for importing engines, if applicable. Note that where a manufacturers' engines are imported through a wide variety of means, EPA would not require this description to be comprehensive. In such cases, a short description of the predominant practices would generally be sufficient. We are also proposing to require manufacturers of engines below 560 kW to name a test lab in the United States for the possibility of us requiring tests under a selective enforcement audit. We have adopted these same requirements in many of our other nonroad programs.

• § 1039.225: Clarify that manufacturers may amend the application for certification after the end of the model year only in certain circumstances, and not to add a new or modified engine configuration.

• § 1039.235: Add an explicit allowance for carryover engine families to include the same kind of within-family running changes that are currently allowed over the course of a model year. The original text may have been understood to require that such running changes be made separate from certifying the engine family for the new model year.

• §§ 1039.235, 1039.240, and 1039.601: Describe how to demonstrate compliance with dual-fuel and flexible-fuel engines. This generally involves testing with each separate fuel, or with a worst-case fuel blend.

• § 1039.240: Add instructions for calculating deterioration factors for sawtooth deterioration patterns, such as might be expected for periodic maintenance, such as cleaning or replacing diesel particulate filters.

• § 1039.240: Remove the instruction related to calculating NMHC emissions from measured THC results, since this is addressed in 40 CFR part 1065.

• § 1039.250: Remove references to routine and standard tests, and remove the shorter recordkeeping requirement for routine data (or data from routine tests). All test records must be kept for eight years. With electronic recording of test data, there should be no advantage to keeping the shorter recordkeeping requirement for a subset of test data. EPA also notes that the eight-year period restarts with certification for a new model year if the manufacturer uses carryover data.

• § 1039.255: Clarify that rendering information false or incomplete after submitting it is the same as submitting false or incomplete information. For example, if there is a change to any corporate information or engine parameters described in the manufacturer's application for certification, the manufacturer must amend the application to include the new information.

• § 1039.255: Clarify that voiding certificates for a recordkeeping or reporting violation would be limited to certificates that relate to the particular recordkeeping or reporting failure.

• § 1039.505: Correct the reference to the ISO C1 duty cycle for engines below 19 kW.

• § 1039.515: Correct the cite to 40 CFR 86.1370.

• §§ 1039.605 and 1039.610: Revise the reporting requirement to require detailed information about the previous year, rather than requiring a detailed projection for the year ahead. The information required in advance would be limited to a notification of plans to use the provisions of these sections.

• § 1039.640: Migrate engine branding to § 1068.45.

• § 1039.701 1039.730: Describe the process for retiring emission credits. This may be referred to as donating credits to the environment.

• § 1039.705: Change terminology for counting engines from ''point of first retail sale'' to ''U.S.-direction production volume.'' This conforms to the usual approach for calculating emission credits for nonroad engines.

• § 1039.710: Clarify that it is not permissible to show a proper balance of credits for a given model by using emission credits from a future model year.

• § 1039.730: Clarify terminology for ABT reports.

• § 1039.740: Clarify that the averaging-set provisions apply for credits generated by Tier 4 engines, not for credits generated from engines subject to earlier standards that are used with Tier 4 engines.

• § 1039.801: Update the contact information for the Designated Compliance Officer.

• § 1039.801: Revise the definition of ''model year'' to clarify that the calendar year relates to the time that engines are produced under a certificate of conformity.

• § 1039.815: Migrate provisions related to confidential information to 40 CFR part 1068.

EPA requests comment on removing regulatory provisions for Independent Commercial Importers in 40 CFR part 1039. These provisions, copied from highway regulations many years ago, generally allow for small businesses to modify small numbers of uncertified products to be in a certified configuration using alternative demonstration procedures. We are not aware of anyone using these provisions for nonroad engines in the last 15 years or more. We are therefore interested in considering these provisions to be obsolete, in which case they can be removed without consequence.

H. Amendments Related to Marine Diesel Engines in 40 CFR Parts 1042 and 1043

EPA's emission standards and certification requirements for marine diesel engines under the Clean Air Act are identified in 40 CFR part 1042.

(1) Continuous NO_X Monitoring and On-Off Controls

Manufacturers may produce certain marine diesel engines with on-off features that disable NO_X controls when the ship is operating outside of a designated Emission Control Area (ECA) as long as certain conditions are met (§ 1042.115(g)). This provision, which applies to Category 3 engines meeting EPA Tier 3 standards, is intended to address the special operating conditions posed by an ECA and allows a ship that operates in and out of designated ECAs to downgrade engine NO_X emission controls while the ship is operating outside of a designated ECA. This provision also applies for Tier 4 NO_X standards for those Category 1 and Category 2 auxiliary engines on Category 3 vessels covered by § 1042.650(d); this provision does not apply to any other auxiliary engines or to any non-Category 3 propulsion engines. Engines with allowable on-off controls must be certified to meet the previous tier of NO_X standards when the advanced NO_X control strategies are disabled (note that this would be Tier 2 for auxiliary engines as well as Category 3 engines, pursuant to § 1042.650(d)).

Engines with on-off NO_X controls are required to be equipped to continuously monitor NO_X concentrations in the exhaust (§ 1042.110(d)). EPA has been asked to clarify what ''continuous'' means in the context of this requirement. Because the purpose of this requirement is to show that the engine complies with the NO_X emission limits on a continuous basis, continuous monitoring must be frequent enough to demonstrate that the NO_X controls are on and are properly functioning from the time the ship enters the ECA until it leaves, which, depending on the ECA and the ship's itinerary, could be a matter of hours or days. Since many manufacturers equip their emission control systems with NO_X sensors to monitoring and log the performance of the combined engine and emission control system, we are proposing that continuous monitoring means measuring NO_X emissions at least every 60 seconds. EPA is also proposing that a manufacturer may request approval of an alternative measurement period if that is necessary for sufficiently accurate measurements. With regard to the functioning of continuous NO_X monitoring, the continuous emission measurement device would be required to be included as part of the engine system for EPA certification. Continuous NO_X monitoring would be required to be engaged before the ship enters an ECA and continue until after it exits the ECA. Verification of operation of the system would be included in required periodic vessel surveys and certification that cover nearly all commercial U.S. vessels. Enforcement is expected to be performed on a periodic basis by appropriate authorities when a ship is in port.

It should be noted that the above provisions with respect to on-off controls and continuous emission monitoring do not apply for the 40 CFR part 1042 PM standards. Engines certified to standards under 40 CFR part 1042 must meet the PM limits at all times, except when the operator has applied for and received permission to disable Tier 4 PM controls while operating outside the United States pursuant to any of the provisions of 40 CFR 1042.650(a) through (c).

(2) Category 1 and Category 2 Auxiliary Engines on Category 3 Vessels

The regulation at 40 CFR 1042.650(d) exempts auxiliary Category 1 and Category 2 engines installed on U.S.-flag Category 3 vessels from the part 1042 standards if those auxiliary engines meet certain conditions. This provision is intended to facilitate compliance with MARPOL Annex VI by certain qualified Category 3 vessels engaged in international trade and to simplify compliance demonstrations while those vessels are operating in foreign ports and foreign waters. EPA is proposing two revisions to make clear that the engines on the Category 3 vessel must remain in compliance with Annex VI, and EPA is providing clarifying language relating to engines with a power output of 130 kW or less.

First, EPA is proposing to revise the regulations to clarify that the urea reporting requirements in § 1042.660(b) (which requires an owner or operator of any vessel equipped with SCR to report to EPA within 30 days of any operation of such vessel without the appropriate reductant) also apply to Category 1 and Category 2 auxiliary engines on Category 3 vessels that are covered by § 1042.650(d). This will extend the urea reporting requirements to engines between 130 and 600 kW if they rely on SCR to meet the Annex VI Tier III NO_X limits. Engines covered by § 1043.650(d) would be subject to emission standards and testing requirements under MARPOL Annex VI and the NO_X Technical Code.

Second, EPA is proposing to revise 40 CFR 1042.650(d) to clarify that, while these Category 1 and Category 2 auxiliary engines may be designed with on-off NO_X controls, Annex VI requires that the engines be certified to meet IMO Tier II NO_X standards anytime the IMO Tier III NO_X configuration is disabled.

EPA has become aware that there is some uncertainty about how the scope of EPA's implementation of Annex VI through 40 CFR part 1043 relates to engines with a power output of 130 kW or less. The existing regulations at § 1043.30 state that an EIAPP certificate is required for engines with a power output above 130 kW, but the standards described in § 1043.60 might be interpreted to apply to engines of all sizes. EPA did not intend to appear to create additional requirements or authority under part 1043 that is not contained in Annex VI or its implementing legislation (the Act to Prevent Pollution from Ships). EPA is therefore proposing to add clarifying language to § 1043.60, consistent with Regulation 13 of Annex VI and APPS, to indicate that the international NO_X limits do not apply to engines with a power output of 130 kW or less. Note that EPA therefore may not issue EIAPP certificates for engines with a power output of 130 kW or less even if manufacturers request it; this also means that such auxiliary engines are not eligible for an exemption under § 1042.650(d).

(3) Natural Gas Marine Engines

EPA is also proposing to expand provisions that apply for marine engines designed to operate on both diesel fuel and natural gas. Test requirements apply separately for each ''fuel type''. EPA generally considers an engine with a single calibration strategy that combines an initial pilot injection of diesel fuel to burn natural gas to be a single fuel type. This applies even if the natural gas portion must be substantially reduced or eliminated to maintain proper engine operation at light-load conditions. If the engine has a different calibration allowing it to run only on diesel fuel, or on continuous mixtures of diesel fuel and natural gas, we would consider it to be a dual-fuel engine or a flexible-fuel engine, respectively. These terms are used consistently across EPA programs for highway and nonroad applications. There is an effort underway to revise the definition of ''dual-fuel'' in MARPOL Annex VI, which may be different than EPA's definition. It should be noted that the 40 CFR part 1042 certification testing requirement differs from that specified in MARPOL Annex VI and the NO_X Technical Code. While the international protocol involves testing only on the engine calibration with the greatest degree of diesel fuel, EPA certification requires manufacturers to perform testing on each separate fuel type. This would involve one set of tests with natural gas (with or without a diesel pilot fuel, as appropriate), and an additional set of tests with diesel fuel alone. This has been required since we first adopted standards, and this is the same policy that applies across all our emission control programs. EPA also proposes to include amended regulatory language to more carefully describe these testing requirements, and to specify how this applies differently for dual-fuel and flexible-fuel engines.

(4) Additional Marine Diesel Amendments

EPA is proposing to make numerous changes across 40 CFR part 1042 to correct errors, to add clarification, and to make adjustments based on lessons learned from implementing these regulatory provisions. This includes the following proposed changes:

- § 1042.1: Correct the tabulated applicability date for engines with per-cylinder displacement between 7 and 15 liters; this should refer to engines ''at or above'' 7 liters, rather than ''above 7 liters''.
- § 1042.1: Replace an incorrect reference to 40 CFR part 89 with a reference to 40 CFR part 94 for marine engines above 37 kW.
- § 1042.2: Add a clarifying note to say that something other than a conventional ''manufacturer'' may need to certify engines that become new after being placed into service (such as engines converted from highway or stationary use). This is intended to address a possible assumption that only

conventional manufacturers can certify engines.

• §§ 1042.30, 1042.730, and 1042.825: Consolidate information-collection provisions into a single section.

• § 1042.101: Revise the text to more carefully identify engine subcategories and better describe the transition between Tier 3 and Tier 4 standards. These changes are intended to clarify which standards apply and are not intended to change the emission standards for any particular size or type of engine.

• § 1042.101 and Appendix III: More precisely define applicability of specific NTE standards for different types of engines and pollutants; correct formulas defining NTE zones and subzones; and add clarifying information to identify subzone points that could otherwise be derived from existing formulas. None of these changes are intended to change the standards, test procedures, or other policies for implementing the NTE standards.

• § 1042.101: Clarify the FEL caps for certain engines above 3700 kW.

• § 1042.101: Add a specification to define ''continuous monitor'' for parameters requiring repeated discrete measurements, as described above. The proposal also includes further clarification on the relationship between on-off NO_X controls and engine diagnostic systems.

• § 1042.110: Remove the requirement to notify operators regarding an unsafe operating condition, since we can more generally rely on the broader provision in § 1042.115 that prohibits manufacturers from incorporating design strategies that introduce an unreasonable safety risk during engine operation.

• § 1042.120: Reduce extended-warranty requirements to warranties that are actually provided to the consumer, rather than to any published warranties that are offered. The principle is that the emission-related warranty should not be less effective for emission-related items than for items that are not emission-related.

• § 1042.125: Allow for special maintenance procedures that address low-use engines. For example, owners of recreational marine vessels may need to perform engine maintenance after a smaller number of hours than would otherwise apply based on the limited engine operation over time.

• § 1042.125: Establish a minimum maintenance interval of 1500 hours for DEF filters. This reflects the technical capabilities for filter durability and the expected maintenance in the field.

• § 1042.135: Clarify that ULSD labeling is required only for engines that use sulfur-sensitive technology. If an engine can meet applicable emission standards without depending on the use of ULSD, the manufacturer should not be required to state on the engine that ULSD is required.

• § 1042.135: Allow for including optional label content only if the manufacturer does not opt to omit other information based on limited availability of space on the label.

• § 1042.201: Clarify that manufacturers may amend their application for certification after the end of the model year in certain circumstances, but they may not produce engines for a given model year after December 31 of the named year.

• § 1042.201: Establish that manufacturers may deliver to EPA for testing an engine that is identical to the test engine used for certification. This may be necessary if the test engine has accumulated too many hours, or if it is unavailable for any reason.

• §§ 1042.205 and 1042.840: Replace the requirement to submit data from invalid tests with a requirement to simply notify EPA in the application for certification if test was invalidated.

• § 1042.225: Clarify that manufacturers may amend the application for certification after the end of the model year only in certain circumstances, and not to add a new or modified engine configuration.

• § 1042.235: Add an explicit allowance for carryover engine families to include the same kind of within-family running changes that are currently allowed over the course of a model year. The original text may have been understood to require that such running changes be made separate from certifying the engine family for the new model year.

• §§ 1042.235, 1042.240, and 1042.601: Describe how to demonstrate compliance with dual-fuel and flexible-fuel engines. This generally involves testing with each separate fuel, or with a worst-case fuel blend.

• § 1042.240: Add instructions for calculating deterioration factors for sawtooth deterioration patterns, such as might be expected for periodic maintenance, such as cleaning or replacing diesel particulate filters.

• § 1042.250: Remove references to routine and standard tests, and remove the shorter recordkeeping requirement for routine data (or data from routine tests). All test records must be kept for eight years. With electronic recording of test data, there should be no advantage to keeping the shorter recordkeeping requirement for a subset of test data. EPA also notes that the eight-year period restarts with certification for a new model year if the manufacturer uses carryover data.

• § 1042.255: Clarify that rendering information false or incomplete after submitting it is the same as submitting false or incomplete information. For example, if there is a change to any corporate information or engine parameters described in the manufacturer's application for certification, the manufacturer must amend the application to include the new information.

• § 1042.255: Clarify that voiding certificates for a recordkeeping or reporting violation would be limited to certificates that relate to the particular recordkeeping or reporting failure.

• § 1042.302: Clarify that manufacturers may fulfill the requirement to test each Category 3 production engine by performing the test before or after the engine is installed in the vessel. The largest Category 3 engines are assembled in the vessel, but some smaller Category 3 engines are assembled at a manufacturing facility where they can be more easily tested. Manufacturers must perform such testing on fully assembled production engines rather than relying on test results from test bed engines.

• § 1042.501: Remove test procedure specifications that are already covered in 40 CFR part 1065.

• § 1042.505: Correct the reference to the ISO C1 duty cycle in 40 CFR part 1039.

• § 1042.515: Remove an incorrect cite.

• §§ 1042.605 and 1042.610: Revise the reporting requirement to require detailed information about the previous year, rather than requiring a detailed projection for the year ahead. The information required in advance would be limited to a notification of plans to use the provisions of these sections.

• § 1042.630: Clarify that dockside examinations are not inspections. Vessels subject to Coast Guard inspection are identified in 46 U.S.C. 3301.

• § 1042.640: Migrate engine branding to § 1068.45.

• § 1042.650: Clarify that vessel operators may modify certified engines if they will be operated for an extended period outside the United States where ULSD will be unavailable. This does not preclude the possibility of vessel operators restoring engines to a certified configuration in anticipation of bring the vessel back to the United States.

• § 1042.660: Identify the contact information for submitting reports related to operation without SCR reductant.

• § 1042.670: Specify that gas turbine engines are presumed to have an equivalent power density below 35 kW per liter of engine displacement; this is needed to identify which Tier 3 standards apply.

• § 1042.701: Clarify that emission credits generated under 40 CFR part 94 may be used for demonstrating compliance with the Tier 3 and Tier 4 standards in 40 CFR part 1042.

• §§ 1042.701 and 1042.730: Describe the process for retiring emission credits. This may be referred to as donating credits to the environment.

• § 1042.705: Change terminology for counting engines from ''point of first retail sale'' to ''U.S.-direction production volume.'' This conforms to the usual approach for calculating emission credits for nonroad engines.

• § 1042.710: Clarify that it is not permissible to show a proper balance of credits for a given model by using emission credits from a future model year.

• § 1042.730: Clarify terminology for ABT reports.

• § 1042.810: Clarify that it is only the remanufacturing standards of subpart I, not the certification standards that are the subject of the applicability determination in § 1042.810.

• § 1042.830: Add a provision to specifically allow voluntary labeling for engines that are not subject to remanufacturing standards, and to clarify that the label is required for engines that are subject to remanufacturing standards.

• § 1042.901: Update the contact information for the Designated Compliance Officer.

• § 1042.901: Revise the definition of ''model year'' to correct cites and clarify that the calendar year relates to the time that engines are produced under a certificate of conformity.

• §§ 1042.901 and 1042.910: Update the reference documents for Annex VI and NO_X Technical Code to include recent changes from the International Maritime Organization.

• § 1042.915: Migrate provisions related to confidential information to 40 CFR part 1068.

I. Amendments Related to Locomotives in 40 CFR Part 1033

EPA's emission standards and certification requirements for locomotives and locomotive engines under the Clean Air Act are identified in 40 CFR part 1033.

EPA is proposing to revise the engine mapping provisions in 40 CFR part 1033 for locomotive testing to denote that manufacturers do not have to meet the cycle limit values in 40 CFR 1065.514 when testing complete locomotives. Also, for engine testing with a dynamometer, while the validation criteria of CFR 1065.514 apply, EPA proposes to allow manufacturers the option to check validation using manufacturer-declared values for maximum torque, power, and speed. This option would allow them to omit engine mapping under 40 CFR 1065.510, which is already not required. These provisions would reduce test burden and cost for the manufacturer, while preserving the integrity of the certification requirements.

EPA is also proposing text that describes the alternate ramped-model cycle provisions in 40 CFR part 1033 as some of the notch setting and durations are inconsistent with the description of the duty cycle in Table 1 of 40 CFR 1033.520. EPA has determined that the table is correct as published and the error lies in the text describing how to carry out the ramped-modal test.

We are also proposing to clarify that locomotives operating on a combination of diesel fuel and gaseous fuel are subject to NMHC standards, which is the same as if the locomotives operated only on gaseous fuel. With respect to in-use fuels, we are proposing a clarification in 40 CFR 1033.815 regarding allowable fuels for certain Tier 4 and later locomotives. Specifically, we would note that locomotives certified on ultra-low sulfur diesel fuel, but that do not include sulfur sensitive emission controls, could use low sulfur diesel fuel instead of ultra-low sulfur diesel fuel, consistent with good engineering judgment. For example, an obvious case where this would be appropriate (but not the only possible case), would be if a railroad had emission data showing the locomotive still met the applicable standards/FELs while operating on the higher sulfur fuel.

EPA is requesting comment on four additional locomotive provisions. The first is the allowance in 40 CFR 1033.101(g)(3) for shorter useful lives for non-locomotive-specific engines—that is, engines not specifically designed for use in locomotives. For normal locomotive engines, the minimum useful life is specified in terms of MW-hrs as the product of the rated horsepower multiplied by 7.50. However, the regulations allow manufacturers/remanufacturers of locomotives with non-locomotive-specific engines to ask for a shorter useful life if the locomotives will rarely operate longer than the shorter useful life. Second, we request comment regarding the need for additional guidance on applying this provision. For example, would it be helpful if we specified that the default alternative minimum useful life under this provision would be 6.00 (instead of 7.50) times the rated horsepower? Third, we request comment on whether EPA should consider notch-specific engine/alternator efficiencies to be confidential business information, and whether we need to update the URL listed in 40 CFR 1033.150(a)(4). Fourth, we request comment on extending the provisions of 40 CFR 1033.101(i) to Tier 4 locomotives. This generally involves a less stringent CO standard in tandem with over-complying with the PM standard. Specifically, this option, which currently applies for Tier 2 and earlier locomotives, requires PM emissions be at least 50 percent below the normally applicable PM standard. The existing provisions were developed to provide a compliance path for natural gas locomotives that reflected both the technological capabilities of natural gas locomotives and the relative environmental significance of CO and PM emissions. This provision was not applied to Tier 4 locomotives, because the applicable Tier 4 p.m. standard is already very low (0.03 g/hp-hr). If we were to apply a similar provision corresponding to Tier 4 standards, we would need to select PM and CO levels that are properly paired to manage this tradeoff. We request comment on whether it is appropriate to pursue such alternate standards, and on the specific numerical standards for PM and CO that would represent an equivalent level of stringency relative to the published standards.

EPA is proposing to make numerous additional changes across 40 CFR part 1033 to correct errors, to add clarification, and to make adjustments based on lessons learned from implementing these regulatory provisions. This includes the following proposed changes:

• §§ 1033.30, 1033.730, and 1033.925: Consolidate information-collection provisions into a single section.

• § 1033.101: Allow manufacturers to certify Tier 4 and later locomotives using Low Sulfur Diesel fuel instead of Ultra-Low Sulfur Diesel fuel. Manufacturers may wish to do this to show that their locomotives do not include sulfur sensitive technology. § 1033.120: Reduce extended-warranty requirements to warranties that are actually provided to customers, rather than to any published warranties that are offered. The principle is that the emission-related warranty should not be less effective for emission-related items than for items that are not emission-related.

- § 1033.201: Clarify that manufacturers may amend their application for certification after the end of the model year in certain circumstances, but they may not produce locomotives for a given model year after December 31 of the named year.
- § 1033.201: Establish that manufacturers may deliver to EPA for testing a locomotive/engine that is identical to the test locomotive/engine used for certification. This may be necessary if the test locomotive/engine has accumulated too many hours, or if it is unavailable for any reason.
- § 1033.225: Clarify that manufacturers may amend the application for certification after the end of the model year only in certain circumstances, and not to add a new or modified locomotive configuration.
- § 1033.235: Add an explicit allowance for carryover engine families to include the same kind of within-family running changes that are currently allowed over the course of a model year. The original text may have been understood to require that such running changes be made separate from certifying the engine family for the new model year.
- §§ 1033.235, 1033.245, and 1033.601: Describe how to demonstrate compliance with dual-fuel and flexible-fuel locomotives. This generally involves testing with each separate fuel, or with a worst-case fuel blend.
- § 1033.245: Add instructions for calculating deterioration factors for sawtooth deterioration patterns, such as might be expected for periodic maintenance, such as cleaning or replacing diesel particulate filters.
- § 1033.250: Remove references to routine and standard tests, and remove the shorter recordkeeping requirement for routine data (or data from routine tests). All test records must be kept for eight years. With electronic recording of test data, there should be no advantage to keeping the shorter recordkeeping requirement for a subset of test data. EPA also notes that the eight-year period restarts with certification for a new model year if the manufacturer uses carryover data.
- § 1033.255: Clarify that rendering information false or incomplete after submitting it is the same as submitting false or incomplete information. For example, if there is a change to any corporate information or engine parameters described in the manufacturer's application for certification, the manufacturer must amend the application to include the new information.
- § 1033.255: Clarify that voiding certificates for a recordkeeping or reporting violation would be limited to certificates that relate to the particular recordkeeping or reporting failure.
- § 1033.501: Clarify how testing requirements apply differently for locomotive engines and for complete locomotives.
- § 1033.501: Add paragraph (a)(4) to remove proportionality verification for discrete-mode tests if a single batch fuel measurement is used to determine raw exhaust flow rate. This verification involves statistical assessment that is not valid for the single data point. Requiring manufacturers instead to simply ensure constant sample flow should adequately address the concern,
- §§ 1033.515 and 1033.520: Update terminology by referring to ''test intervals'' instead of ''phases''. This allows us to be consistent with terminology used in 40 CFR part 1065.
- § 1033.520: Correct the example given to describe the testing transition after the second test interval.
- §§ 1033.701 and 1033.730: Describe the process for retiring emission credits. This may be referred to as donating credits to the environment.
- § 1033.710: Clarify that it is not permissible to show a proper balance of credits for a given model by using emission credits from a future model year.
- § 1033.730: Clarify terminology for ABT reports.
- § 1033.815: Add consideration of periodic locomotive inspections in 184-day intervals.
- § 1033.901: Update the contact information for the Designated Compliance Officer.
- § 1033.915: Migrate provisions related to confidential information to 40 CFR part 1068.

J. Miscellaneous EPA Amendments

EPA is proposing to clarify that the cold NMHC standards specified in 40 CFR 86.1811–17 do not apply at high altitude. We intended in recent amendments to state that the cold CO standards apply at both low and high altitude, but inadvertently placed that statement where it also covered cold NMHC standards, which contradicts existing regulatory provisions that clearly describe the cold NMHC standards as applying only for low-altitude testing. The proposed change would simply move the new clarifying language to apply only to cold CO standards. We are also proposing to restore the cold NMHC standards in paragraph (g)(2), which were inadvertently removed as part of the earlier amendments.

EPA is proposing to revise the specifications for Class 2b and Class 3 vehicles certifying early to the Tier 3 exhaust emission standards under 40 CFR 86.1816–18 to clarify that carryover values for PM and formaldehyde apply. The preamble to the earlier final rule described these standards properly, but the regulations inadvertently pointed to the Tier 3 values for PM and formaldehyde for these vehicles.

EPA is proposing to make a minor correction to the In-Use Compliance Program under 40 CFR 86.1846–01. A recent amendment describing how to use SFTP test results in the compliance determination inadvertently removed a reference to low-mileage SFTP testing. We are proposing to restore the removed text.

EPA is proposing to revise the instruction for creating road-load coefficients for cold temperature testing in 40 CFR 1066.710 to simply refer back to 40 CFR 1066.305 where this is described more generally. The text originally adopted in 40 CFR 1066.710 incorrectly describes the calculation for determining those coefficients.

EPA is also proposing two minor amendments related to highway motorcycles. First, we are proposing to correct an error related to the small-volume provisions for highway motorcycles. The regulation includes an inadvertent reference to a small-volume threshold based on an annual volume of 3,000 motorcycles produced in the United States. As written, this would not consider any foreign motorcycle production for importation into the United States. This error is corrected by simply revising the text to refer to an annual production volume of motorcycles produced ''for'' the United States. This would properly reflect small-volume production as it relates to compliance with EPA standards. Second, we are proposing to clarify the language describing how to manage the precision of emission results, both for measured values and for calculating values when applying a deterioration factor. This involves a new reference to the rounding procedures in 40 CFR part 1065 to replace the references to outdated ASTM procedures. EPA is proposing in 40 CFR 1037.601(a)(3) to clarify that the Clean Air Act does not allow any person to disable, remove, or render inoperative (*i.e.,* tamper with) emission controls on a certified motor vehicle for purposes of competition. An existing provision in 40 CFR 1068.235 provides an exemption for nonroad engines converted for competition use. This provision reflects the explicit exclusion of engines used solely for competition from the CAA definition of ''nonroad engine''. The proposed amendment clarifies that this part 1068 exemption does not apply for motor vehicles.

K. Amending 49 CFR Parts 512 and 537 To Allow Electronic Submissions and Defining Data Formats for Light-Duty Vehicle Corporate Average Fuel Economy (CAFE) Reports

To improve efficiency and reduce the burden to manufacturers and the agencies, NHTSA is proposing to modify 49 CFR part 537 eliminating the option for manufacturers to submit pre-model, mid-model and supplemental reports on CD–ROMS and require only one electronic submission (for each report) electronically via a method proscribed by NHTSA. NHTSA is introducing a new electronic format to standardize the method for collecting manufacturer's information. NHTSA also proposes to modify 49 CFR part 512 to include and protect submitted CAFE data elements that need to be treated as confidential business information.

49 CFR part 537 currently requires manufacturers to provide reports to NHTSA containing projected estimates of how manufacturers plan to comply with NHTSA standards. In the CAFE final rule for vehicles manufactured for model years 2017–2025, NHTSA modified its reporting requirements at 49 CFR 537.5(c)(4) to eliminate the option for manufacturers to mail hardcopy submissions of CAFE reports to NHTSA and required all reports to be submitted electronically by CD–ROM (CBI and non-CBI versions) or by email (non-CBI version).[881] Currently, any data provided in the manufacturer's report is required in MS-Excel spreadsheet format. Supporting documentation such as cover letters or requests for confidentiality is required to be provided in a pdf format.

NHTSA is proposing to change the required format for CAFE data required under 49 CFR 537.7(b) and (c) in order to standardize submissions and better align with data provided to EPA. For model year 2013 through 2015 most manufacturer reports received by NHTSA lacked the required format adopted in the 2017–2025 final rule. NHTSA is therefore adopting a standardized template for manufacturers to report model type level data. The template organizes the required data in a consistent manner, adopts formats for values consistent with those provided to EPA for similar values and calculates manufacturer's target standard. Calculating target standards is preferred because it reduces errors in manufacturer's determinations. However, NHTSA's long-term goal is to standardize the required data for incorporation into an electronic database system and this first step facilities a structure for coding the electronic data which will ultimately reduce manufacturer's and the government's burden for reporting.

NHTSA rationalizes that establishing a required format is necessary because manufacturers may not understand how to provide the required CAFE data. In the 2017 to 2025 final rule, NHTSA modified its base tire definition to better align with the approach manufacturers use to determine model type target standards. CAFE standards are attribute based, and thus each manufacturer has its own ''standard,'' or compliance obligation, defined by the vehicles it produces for sale in each fleet in a given model year. A manufacturer calculates its fleet standard from the attribute based target curve standards derived from the unique footprint values, which are the products of the average front and rear vehicle track width and wheelbase dimensions, of the vehicles in each model type. Vehicle track width dimensions are determined with a vehicle equipped with ''base tires,'' which NHTSA currently defines in 49 CFR part 523 as (for passenger automobiles, light trucks, and medium duty passenger vehicles) the tire size specified as standard equipment by the manufacturer on each unique combination of a vehicle's footprint and model type. Standard equipment is defined in 40 CFR 86.1803–01. NHTSA made these changes to provide a clear definition for footprint calculations and, thus, fleet compliance projections, calculations, finalizations and enforcement efforts. Beginning in model year 2013, as modified in 49 CFR 537.7(b), manufacturers were to provide attribute characteristics and standards in consideration of the change in the base tire definition for each unique model type and footprint combination of the manufacturer's automobiles. Manufacturers were required to provide the data listed by model types in order of increasing average inertia weight from top to bottom down the left side of the table and list the information categories in the order specified in 49 CFR 537.7(b)(3)(i) and (ii) from left to right across the top of the table. Manufacturers could also provide the data using any format required by EPA, which contains all of the required information in a readily identifiable format.

In the 2017–2025 final rule, additional changes to NHTSA's reporting requirements also included a modification to 49 CFR 537.7(b) to restructure and clarify how manufacturers report information used to make the determination that an automobile can be classified as a light truck for CAFE purposes. The agency felt that this proposed change was necessary because the previous requirements in 49 CFR part 537 specified that manufacturers must provide information on some, but not all, of the functions and features used to classify an automobile as a light truck, and it is important for compliance reasons to understand and be able to readily verify the methods used to ensure manufacturers are classifying vehicles correctly. Furthermore, the previous regulation required that the information be distributed in different locations throughout a manufacturer's report, making it difficult for the agency to clearly determine exactly what functions or features a manufacturer is using to classify a vehicle as a light truck. Therefore, NHTSA streamlined the location of all its provisions for defining vehicle classifications into one consolidate section. With these changes, manufacturers can provide the agency with all the necessary data in a simpler format that allows the agency, and perhaps also the manufacturer, to understand quickly and easily how light truck vehicle classification determination decisions are made.

In reviewing manufacturers current reporting, most manufacturers are still failing to provide the required information for classifying light trucks. For the model year 2015 pre-model year reports, only a few manufacturers provided the required information and many provided the information incorrectly. Therefore, NHTSA is also proposing to incorporate an additional template for collecting vehicle configuration level data which includes vehicle classification information. Similarly, the template will standardize the format of the data with values required by EPA and structures the data for future incorporation into a database system. Finally, the template also simplifies reporting by not having manufacturers report all vehicle classification characteristics but only those used by the manufacturer in qualifying a vehicle as a light truck. NHTSA is adopting this provision to better align with EPA current database structure which uses a similar approach in accepting light truck level data.

[881] 77 FR 62624, October 15, 2012.

XV. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review

This action is an economically significant regulatory action that was submitted to the Office of Management and Budget (OMB) for review. Any changes made in response to OMB recommendations have been documented in the docket. The agencies prepared an analysis of the potential costs and benefits associated with this action. This analysis, the draft ''Regulatory Impact Analysis—Heavy-Duty GHG and Fuel Efficiency Standards NPRM,'' is available in the docket. The analyses contained in this document are also summarized in Sections VII, VIII, and IX of this preamble.

B. National Environmental Policy Act

NHTSA has initiated the Environmental Impact Statement (EIS) process under the National Environmental Policy Act (NEPA), 42 U.S.C. 4321–4347, and implementing regulations issued by the Council on Environmental Quality (CEQ), 40 CFR part 1500, and NHTSA, 49 CFR part 520. On July 9, 2014, NHTSA published a notice of intent to prepare an EIS for this rulemaking and requested scoping comments (79 FR 38842). The notice invited Federal, State, and local agencies, Indian tribes, stakeholders, and the public to participate in the scoping process and to help identify the environmental issues and reasonable alternatives to be examined in the EIS.

Concurrently with this proposed rule, NHTSA is releasing a Draft Environmental Impact Statement (DEIS). NHTSA prepared the DEIS to analyze and disclose the potential environmental impacts of the proposed HD fuel consumption standards and reasonable alternatives. Environmental impacts analyzed in the DEIS include those related to fuel and energy use, air quality, and climate change. The DEIS also describes potential environmental impacts to a variety of resource areas, including water resources, biological resources, land use and development, safety, hazardous materials and regulated wastes, noise, socioeconomics, and environmental justice. These resource areas are assessed qualitatively in the DEIS.

The DEIS analyzes five alternative approaches to regulating HD vehicle fuel consumption, including a ''preferred alternative'' and a ''no action alternative.'' The DEIS evaluates a reasonable range of alternatives under NEPA, and analyzes the direct, indirect, and cumulative impacts of those alternatives in proportion to their significance.

Because of the link between the transportation sector and GHG emissions, NHTSA recognizes the need to consider the possible impacts on climate and global climate change in the analysis of the effects of these fuel consumption standards. NHTSA also recognizes the difficulties and uncertainties involved in such an impact analysis. Accordingly, consistent with CEQ regulations on addressing incomplete or unavailable information in environmental impact analyses, NHTSA has reviewed existing credible scientific evidence that is relevant to this analysis and summarized it in the DEIS. NHTSA has also employed and summarized the results of research models generally accepted in the scientific community.

Although the alternatives have the potential to decrease GHG emissions substantially, they do not prevent climate change, but only result in reductions in the anticipated increases in CO_2 concentrations, temperature, precipitation, and sea level. They would also, to a small degree, delay the point at which certain temperature increases and other physical effects stemming from increased GHG emissions would occur. As discussed in the EIS, NHTSA presumes that these reductions in climate effects will be reflected in reduced impacts on affected resources.

The DEIS has informed NHTSA decision makers in their preparation of this proposed rule and in the ongoing rulemaking process. NHTSA invites comments on the DEIS from Federal, State, and local agencies, Indian tribes, stakeholders, and the public. Instructions for submission of such comments are included in the DEIS.

For additional information on NHTSA's NEPA analysis, please *see* the DEIS. The DEIS is available on NHTSA's Web site and on *http://www.regulations.gov* in Docket No. NHTSA–2014–0074.

C. Paperwork Reduction Act

The information collection activities in these proposed rules have been submitted for approval to the Office of Management and Budget (OMB) under the PRA. The Information Collection Request (ICR) document that EPA prepared has been assigned EPA ICR number 2394.04. You can find a copy of the ICR in the docket for these proposed rules, and it is briefly summarized here.

The agencies propose to collect information to ensure compliance with the provisions in this proposal. This includes a variety of testing, reporting and recordkeeping requirements for vehicle and engine manufacturers. Section 208(a) of the CAA requires that manufacturers provide information the Administrator may reasonably require to determine compliance with the regulations; submission of the information is therefore mandatory. We will consider confidential all information meeting the requirements of Section 208(c) of the CAA.

Respondents/affected entities: Respondents are manufacturers of engines and vehicles within the North American Industry Classification System (NAICS) and use the coding structure as defined by NAICS. 336111, 336112, 333618, 336120, 541514, 811112, 811198, 336111, 336112, 422720, 454312, 541514, 541690, 811198, 333618, 336510, for Motor Vehicle Manufacturers, Engine and Truck Manufacturers, Truck Trailer Manufacturers, Commercial Importers of Vehicles and Vehicle Components, and Alternative Fuel Vehicle Converters and Manufacturers.

Respondent's obligation to respond: The information that is subject to this collection is collected whenever a manufacturer applies for a certificate of conformity. Under section 206 of the CAA (42 U.S.C. 7521), a manufacturer must have a certificate of conformity before a vehicle or engine can be introduced into commerce.

Estimated number of respondents: It is estimated that this collection affects approximately 155 engine and vehicle manufacturers.

Frequency of response: Annually.

Total estimated burden: The burden to the manufacturers affected by these rules has a range based on the number of engines and vehicles a manufacturer produces. The estimated average annual respondent burden associated with the first three implementation years of the Phase 2 program is 62,400 hours (*see* Table XV–1). This estimated burden for engine and vehicle manufacturers is an average estimate for both new and existing reporting requirements for calendar years 2017, 2018 and 2019, in which trailer manufacturers will prepare for and begin certifying for Phase 2 while Phase 1 will continue for the other affected manufacturers. Burden is defined at 5 CFR 1320.3(b). Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

TABLE XV–1—BURDEN FOR REPORTING AND RECORDKEEPING REQUIREMENTS

Number of Affected Vehicle Manufacturers.	155.
Annual Labor Hours for Each Manufacturer to Prepare and Submit Required Information.	Varies.
Total Annual Information Collection Burden.	62,400 Hours.

Total estimated cost: The estimated average annual cost associated with the first three implementation years of the Phase 2 program is approximately $8 million. This includes approximately $3.3 million in capital and operation & maintenance costs. This estimated cost for engine and vehicle manufacturers is an average estimate for both new and existing testing, recordkeeping, and reporting requirements for calendar years 2017, 2018 and 2019, in which trailer manufacturers will prepare for and begin certifying for Phase 2 while Phase 1 will continue for the other affected manufacturers.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in title 40 are listed in 40 CFR part 9.

Submit your comments on the agencies' need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to EPA and NHTSA using the docket identified at the beginning of these proposed rules. You may also send your ICR-related comments to OMB's Office of Information and Regulatory Affairs via email to *oira_submissions@omb.eop.gov*, Attention: Desk Officer for EPA. Since OMB is required to make a decision concerning the ICR between 30 and 60 days after receipt, OMB must receive comments no later than August 12, 2015. The agencies will respond to any ICR-related comments in the final rules.

NHTSA also separately submitted a request to OMB for approval of a change to an information collection activity that is proposed in this rulemaking. The information collection request was previously assigned ICR No. 2127–0019 for 49 CFR part 537, ''Automotive Fuel Economy Reports.''

The existing collection involves vehicle manufacturers submitting reports to the Secretary of Transportation with preliminary estimates demonstrating their ability to comply with corporate average fuel economy standards (CAFE) established by 49 U.S.C. 32902 for each model year. To improve efficiency and reduce manufacturers' and the government's burden, NHTSA is proposing to modify 49 CFR part 537 to require CAFE reports to be submitted electronically via an electronic database using a standardized data format. The total estimated amount of paperwork burden resulting from this action that the federal government is imposing on private businesses and citizens is summarized below.

Respondents: Automobile manufacturers.

Estimated Number of Respondents: 30.

Estimated Number of Responses: 54. Some manufacturers have multiple fleets (domestic passenger car, import passenger car, light truck) and 49 CFR part 537 requires a separate report for each fleet.

Estimated Total Annual Burden: Thirty automotive manufacturers must comply with 49 CFR 537. For each current model year, each manufacturer is required to submit semi-annual reports: A pre-model year report and a mid-model year report. The pre-model year report must be submitted during the month of December, and the mid-model year report must be submitted during the month of July. The total number of responses submitted by automotive manufacturers is 54. We currently have a clearance based on reports being received from 22 manufacturers with an estimated total annual burden of 2,339 hours. Including 8 additional manufacturers, results in an additional reporting burden of 850 hours. Adding that burden to the existing burden of 2,339 hours, results in a total of 3,189 hours.

Estimated Frequency: A pre-model report and a mid-model report are required to be submitted by manufacturers once per model year for each applicable fleet (domestic passenger car, imported passenger car and light trucks).

A copy of the 60 day notice for this ICR containing the proposed changes is included in the docket for this rule.

NHTSA seeks public comments on all aspects of this information collection, including (a) whether the proposed collection of information is necessary for the Department's performance, (b) the accuracy of the estimated burden, (c) ways for the Department to enhance the quality, utility and clarity of the information collection and (d) ways that the burden could be minimized without reducing the quality of the collected information.

D. Regulatory Flexibility Act

Pursuant to section 603 of the RFA, the agencies prepared an initial regulatory flexibility analysis (IRFA) that examines the impact of the proposed rules on small entities along with regulatory alternatives that could minimize that impact. The complete IRFA is available for review in the docket and is summarized here. As required by section 609(b) of the RFA, EPA convened a Small Business Advocacy Review (SBAR) Panel to obtain advice and recommendations from small entity representatives that potentially would be subject to the rule's requirements. The SBAR Panel evaluated the assembled materials and small-entity comments on issues related to elements of an IRFA. A copy of the full SBAR Panel Report is available in the rulemaking docket.

(1) Overview

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of today's rules on small entities, small entity is defined as: (1) A small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201 (see table below); (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for profit enterprise which is independently owned and operated and is not dominant in its field.

Table XV–2 provides an overview of the primary SBA small business categories potentially affected by this regulation.

TABLE XV–2—PRIMARY SMALL BUSINESS CATEGORIES POTENTIALLY AFFECTED BY THIS REGULATION

Industry expected in rulemaking	Industry NAICS[a] code	NAICS description	Defined as small entity by SBA if less than or equal to:
Alternative Fuel Engine Converters	333999	Misc. General Purpose Machinery	500 employees.
	811198	All Other Automotive Repair & Maintenance	$7.0 million (annual receipts).
Voc. Vehicle Chassis Manufacturers	336120	Heavy-Duty Truck Manufacturing	1,000 employees.
HD Trailer Manufacturers	336212	Truck Trailer Manufacturing	500 employees.
	333924	Industrial Truck, Trailer & Stacker Machinery	750 employees.

Note:
[a] North American Industrial Classification System.

(2) Legal Basis for Agency Action

Heavy-duty vehicles are classified as those with gross vehicle weight ratings (GVWR) of greater than 8,500 lb. Section 202(a) of the Clean Air Act (CAA) allows EPA to regulate new vehicles and new engines by prescribing emission standards for pollutants which the Administrator finds ''may reasonably be anticipated to endanger public health or welfare.'' In 2009, EPA found that six greenhouse gases (GHGs) were anticipated to endanger public health or welfare, and new motor vehicles and new motor vehicle engines contribute to that pollution. This finding was upheld by the unanimous court in *Coalition for Responsible Regulation* v. *EPA,* 684 F. 3d 102 (D.C. Cir. 2012). Acting under the authority of the CAA, EPA set the first phase of heavy-duty vehicle GHG standards (Phase 1) and specified certification requirements for emissions of four GHGs emitted by mobile sources: Carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and hydrofluorocarbons (HFC).

(3) Summary of Potentially Affected Small Entities

Table XV–2 above lists industries/sectors potentially affected by the proposed rules. EPA is not aware of any small businesses who manufacture complete heavy-duty pickup trucks and vans, heavy-duty engines, or Class 7 and 8 tractors.

EPA used the criteria for small entities developed by the Small Business Administration under the North American Industry Classification System (NAICS) as a guide. Information about these entities comes from sources including EPA's certification data, trade association databases, and previous rulemakings that have affected these industries. EPA then found employment information for these companies using the business information database Hoover's Online (a subsidiary of Dan and Bradstreet). These entities fall under the categories listed in the table.

(4) Potential Reporting, Recordkeeping and Compliance Burdens

For any emission control program, EPA must have assurances that the regulated products will meet the standards. The program that EPA is considering for manufacturers subject to this proposal will include testing, reporting, and recordkeeping requirements. Testing requirements for these manufacturers could include use of EPA's Greenhouse gas Emissions Model (GEM) vehicle simulation tool to obtain the overall CO_2 emissions rate for certification of vocational chassis and trailers, aerodynamic testing to obtain aerodynamic inputs to GEM for some trailer manufacturers and engine dynamometer testing for alternative fuel engine converters to ensure their conversions meet the proposed CO_2, CH_4 and N_2O engine standards. Reporting requirements would likely include emissions test data or model inputs and results, technical data related to the vehicles, and end-of-year sales information. Manufacturers would have to keep records of this information.

(5) Related Federal Rules

The primary federal rule that is related to the proposed Phase 2 rules under consideration is the 2011 Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (76 FR 57106). This Phase 1 rulemaking would continue to be in effect in the absence of these proposed rules. Several Federal rules relate to heavy-duty vehicles and to the proposed Phase 2 rules under consideration. The Department of Transportation, through NHTSA, has several safety requirements for these vehicles. California adopted its own greenhouse gas initiative, which places aerodynamic requirements on trailers used in long-haul applications. None of these existing regulations were found to conflict with the proposed rulemaking.

(6) Summary of SBREFA Panel Process and Panel Outreach

(a) Significant Panel Findings

The Small Business Advocacy Review Panel (SBAR Panel, or the Panel) considered regulatory options and flexibilities to help mitigate potential adverse effects on small businesses as a result of these rules. During the SBREFA Panel process, the Panel sought out and received comments on the regulatory options and flexibilities that were presented to SERs and Panel members. The recommendations of the Panel are described below and are also located in Section XX of the SBREFA Final Panel Report, which is available in the public docket.

(b) Panel Process

As required by Section 609(b) of the RFA, as amended by SBREFA, we also conducted outreach to small entities and convened an SBAR Panel to obtain advice and recommendations of representatives of the small entities that potentially would be subject to the rule's requirements. On October 22, 2014, EPA's Small Business Advocacy Chairperson convened a Panel under Section 609(b) of the RFA. In addition to the Chair, the Panel consisted of the Division Director of the Assessment and Standards Division of EPA's Office of Transportation and Air Quality, the Chief Counsel for Advocacy of the Small Business Administration, and the Administrator of the Office of Information and Regulatory Affairs within the Office of Management and Budget.

As part of the SBAR Panel process, we conducted outreach with representatives of small businesses that would potentially be affected by the proposed rulemaking. We met with these Small Entity Representatives (SERs) to discuss the potential rulemaking approaches and potential options to decrease the impact of the rulemaking on their industries. We distributed outreach materials to the SERs; these materials included background on the rulemaking, possible regulatory approaches, and possible rulemaking alternatives. The Panel met with SERs from the industries that would be directly affected by the Phase 2 rules on November 5, 2014 (trailer manufacturers) and November 6, 2014 (engine converters and vocational vehicle chassis manufacturers) to discuss the outreach materials and receive feedback on the approaches and alternatives detailed in the outreach packet. The Panel also met with SERs on July 19, 2014 for an initial, introductory outreach meeting, and held a supplementary outreach meeting with the trailer manufacturer SERs on October 28, 2014. The Panel received written comments from the SERs following each meeting in response to discussions had at the meeting and the questions posed to the SERs by the agency. The SERs were specifically asked to provide comment on regulatory alternatives that could help to minimize the rule's impact on small businesses.

The Panel's findings and discussions were based on the information that was available during the term of the Panel and issues that were raised by the SERs during the outreach meetings and in their comments. It was agreed that EPA should consider the issues raised by the SERs and discussions had by the Panel itself, and that EPA should consider comments on flexibility alternatives that would help to mitigate negative impacts on small businesses to the extent legally allowable by the Clean Air Act.

Alternatives discussed throughout the Panel process included those offered in previous or current EPA rulemakings, as well as alternatives suggested by SERs and Panel members. A summary of these recommendations is detailed below, and a full discussion of the regulatory alternatives and hardship provisions discussed and recommended by the Panel can be found in the SBREFA Final Panel Report. A complete discussion of the provisions for which we are requesting comment and/or proposing in this action can be found in Sections IV.E and V.D of this preamble. Also, the Panel Report includes all comments received from SERs (Appendix B of the Report) and summaries of the two outreach meetings that were held with the SERs. In accordance with the RFA/SBREFA requirements, the Panel evaluated the aforementioned materials and SER comments on issues related to the IRFA. The Panel's recommendations from the Final Panel Report are discussed below.

(c) Panel Recommendations

(i) Small Business Trailer Manufacturers

Comments from trailer manufacturer SERs indicated that these companies are familiar with most of the technologies described in the materials, but have no experience with EPA certification and do not anticipate they could manage the accounting and reporting requirements without additional staff and extensive training. Performance testing, which is a common requirement for many of EPA's regulatory programs, is largely unfamiliar to these small business manufacturers and the SERs believed the cost of testing would be a significant burden on their companies. In light of this feedback, the Panel recommended a combination of streamlined compliance and targeted exemptions for these small businesses based on the specific trailer types that they manufacture. The Panel believed these strategies would achieve many of the benefits for the environment by driving adoption of CO_2-reducing technologies, while significantly reducing the burden that these new regulations would introduce on small businesses.

(ii) Box Trailer Manufacturers

Box trailer manufacturers have the benefit of relying on the aerodynamic technology development initiated through EPA's voluntary SmartWay program. The Panel was aware that EPA was planning to propose a simplified compliance program for all manufacturers, in which aerodynamic device manufacturers have the opportunity to test and certify their devices with EPA as technologies that can be used by trailer manufacturers in their trailer certification. This pre-approved technology strategy was intended to provide all trailer manufactures a means of complying with the standards without the burden of testing. In the event that this strategy is limited to the early years of the trailer program for all manufactures, the Panel recommended that small manufacturers continue to be given the option to use pre-approved devices in lieu of testing.

In the event that small trailer manufacturers adopt pre-approved aerodynamic technologies and the appropriate tire technologies for compliance, the Panel recommended an alternative compliance pathway in which small business trailer manufacturers could simply report to EPA that all of their trailers include approved technologies in lieu of collecting all of the required inputs for the GEM vehicle simulation.

(iii) Non-Box Trailer Manufacturers

The Panel recommended no aerodynamic requirements for non-box trailers. The non-box trailer SERs indicated that they had no experience installing aerodynamic devices and had only seen them in prototype-level demonstrations. In terms of the aerodynamic devices in use today, most non-box trailer SERs identified unique operations in which their trailers are used that preclude the use of those technologies.

Some non-box trailer manufacturers had experience with LRR tires and ATI systems. However, the non-box trailer manufacturer SERs indicated that LRR tires are not currently available for some of their trailer types. The SERs noted that tire manufacturers are currently focused on box trailer applications and there are only a few LRR tire models that meet the needs of their customers. The Panel recommended EPA ensure appropriate availability of these tires in order for it to be deemed a feasible means of achieving these standards and recommended a streamlined compliance process based on the availability of technologies. The Panel suggested the best compliance option from a small business perspective would be for EPA to pre-approve tires, similar to the approach being proposed for aerodynamic technologies, and to maintain a list that could be used to exempt small businesses when no suitable tires are available. However, the Panel recognized the difficulties of maintaining an up-to-date list of certified technologies. The Panel recommended that, if EPA did not adopt the list-based approach, the agency consider a simplified letter-based compliance option that allows manufacturers to petition EPA for an exemption if they are unable to identify tires that meet the LRR performance requirements on a trailer family basis.

(iv) Non-Highway Trailer Manufacturers

The Panel recommended excluding all trailers that spend a significant amount of time in off-road applications. These trailers may not spend much time at highway speeds and aerodynamic devices may interfere with the vehicle's intended purpose. Additionally, tires with lower rolling resistance may not provide the type of traction needed in off-road applications.

(v) Compliance Provisions for All Small Trailer Manufacturers

Due to the potential for reducing a small business's competitiveness compared to the larger manufacturers, as well as the ABT record-keeping burden, the Panel recommended that EPA consider small business flexibilities to allow small entities to opt out of ABT without placing themselves at a competitive disadvantage to larger firms that adopt ABT, such as a low volume exemption or requiring only LRR where appropriate. EPA was asked to consider flexibilities for small businesses that would ease and incentivize their participation in ABT, such as streamlined the tracking requirements for small businesses. In addition, the Panel recommended that EPA request comment on the feasibility and consequences of ABT for the trailer program and additional flexibilities that will promote small business participation.

(vi) Lead Time Provisions for All Small Trailer Manufacturers

For all trailer types that will be included in the proposal, the Panel recommended a 1-year delay in implementation for small trailer manufacturers at the start of the proposed rulemaking to allow them additional lead time to make the proper staffing adjustments and process changes and possibly add new infrastructure to meet these requirements. In the event that EPA is unable to provide pre-approved technologies for manufacturers to choose for compliance, the Panel recommended that EPA provide small business trailer manufacturers an additional 1-year delay for each subsequent increase in stringency. This additional lead time will allow these small businesses to research and market the technologies required by the new standards.

(vii) Small Business Alternative Fuel Engine Converters

To reduce the compliance burden of small business engine converters who convert engines in previously-certified complete vehicles, the Panel recommended allowing engine compliance to be sufficient for certification. This would mean the converted vehicle would not need to be recertified *as a vehicle.* This flexibility would eliminate the need for these small manufacturers to gather all of the additional component-level information in addition to the engine CO_2 performance necessary to properly certify a vehicle with GEM (*e.g.,* transmission data, aerodynamic performance, tire rolling resistance, etc.). In addition, the Panel recommended that small engine converters be able to submit an engineering analysis, in lieu of measurement, to show that their converted engines do not increase N_2O emissions. Many of the small engine converters are converting SI-engines, and the catalysts in these engines are not expected to substantially impact N_2O production. Small engine converters that convert CI-engines could likely certify by ensuring that their controls require changes to the SCR dosing strategies.

The Panel did not recommend separate standards for small business natural gas engine manufacturers. The Panel believes this would discourage entrance for small manufactures into this emerging market by adding unnecessary costs to a technology that has the potential to reduce CO_2 tailpipe emissions. In addition, the Panel noted that additional leakage requirements beyond a sealed crankcase for small business natural gas-fueled CI engines and requirements to follow industry standards for leakage could be waived for small businesses with minimal impact on overall GHG emissions.

Finally, the Panel recommended that small engine converters receive a one-year delay in implementation for each increase in stringency throughout the proposed rules. This flexibility will provide small converters additional lead time to obtain the necessary equipment and perform calibration testing if needed.

(viii) Emergency Vehicle Chassis Manufacturers

Fire trucks, and many other emergency vehicles, are built for high level of performance and reliability in severe-duty applications. Some of the CO_2-reducing technologies listed in the materials could compromise the fire truck's ability to perform its duties and many of the other technologies simply provide no benefit in real-world emergency applications. The Panel recommended proposing less stringent standards for emergency vehicle chassis manufactured by small businesses. The Panel suggested that feasible standards could include adoption of LRR tires at the baseline Phase 2 level and installation of a Phase 2-compliant engine. In addition, the Panel recommended a simplified certification approach for small manufacturers who make chassis for emergency vehicles that reduces the number of inputs these manufacturers must obtain for GEM.

(ix) Off-Road Vocational Vehicle Chassis Manufacturers

EPA is planning to propose to continue the exemptions in Phase 1 for off-road and low-speed vocational vehicles (see generally 76 FR 57175). These provisions currently apply for vehicles that are defined as ''motor vehicles'' per 40 CFR 85.1703, but may conduct most of their operations off-road. Vehicles qualifying under these provisions must comply with the applicable engine standard, but need not comply with a vehicle-level GHG standard. The Panel concluded this exemption is sufficient to cover the small business chassis manufacturers who design chassis for off-road vocational vehicles.

(x) Custom Chassis Manufacturers

The Panel concluded that chassis designed for specialty operations often have limited ability to adopt CO_2- and fuel consumption-reducing technologies due to their unique use patterns. In addition, the manufacturers of these chassis have very small annual sales volumes. The Panel recommended that EPA propose a low volume exemption for these custom chassis manufacturers. The Panel did not receive sufficient information to recommend a specific sales volume, but recommended that EPA request comment on how to design a small business exemption by means of a volume exemption, and an appropriate annual sales volume threshold.

(xi) Glider Manufacturers

The Panel was aware that EPA would like to reduce the use of glider kits, which have higher emissions of criteria pollutants like NO_X than current engines, and which could have higher GHG emissions than Phase 2 engines. However, the Panel estimates that the number of vehicles produced by the small businesses who manufacturer glider kits is too small to have a substantial impact on the total heavy-duty inventory and recommended that existing small businesses be allowed to continue assembling glider vehicles without having to comply with the GHG requirements. The Panel recommended that EPA establish an allowance for existing small business glider manufacturers to produce some number of glider kits for legitimate purposes, such as for newer vehicles badly damaged in crashes. The Panel recommended that any other limitations on small business glider production be flexible enough to allow sales levels as high as the peak levels in the 2010–2012 timeframe.

(7) Summary of Projected Impact on Small Businesses

EPA has chosen to propose the Panel's recommended regulatory flexibility provisions for small business alternative fuel converters and vocational vehicle chassis manufacturers and we believe that all of the small businesses in these industries will be impacted by less than one percent of their annual sales. EPA is also proposing many of the Panel's recommendations for small business trailer manufacturers, including seeking comment on the possibility of a small volume exemption. A majority of the small trailer manufacturers produce non-box trailers, and are not required to adopt aerodynamic devices in this proposal. Additionally, many of the smallest trailer manufacturers produce specialty trailers that are candidates for exemption under the proposed off-highway or heavy-haul provisions described in Section IVC.(5). At this time, EPA believes the additional flexibilities offered for small business trailer manufacturers will reduce their burden below three percent of their annual sales. A more detailed description of the analysis to quantify the impact on small businesses in each affected industry sector is included in the IRFA as presented in Chapter 12 of the draft RIA for this rulemaking. EPA invites comment on all aspects of the proposal and its impacts on small entities.

E. Unfunded Mandates Reform Act

This action contains a federal mandate under UMRA, 2 U.S.C. 1531–1538, that may result in expenditures of $100 million or more for state, local and tribal governments, in the aggregate, or the private sector in any one year. Accordingly, the agencies have prepared a statement required under section 202 of UMRA. The statement is included in the docket for this action and briefly summarized here.

The agencies have prepared a statement of the cost-benefit analysis as required by Section 202 of the UMRA; this discussion can be found in this preamble, and in the draft RIA. The agencies believe that the proposal represents the least costly, most cost-effective approach to achieve the statutory requirements of the rules. Section IX explains why the agencies believe that the fuel savings that would result from this proposal would lead to lower prices economy wide, improving U.S. international competitiveness. The costs and benefits associated with the proposal are discussed in more detail above in Section IX and in the Draft Regulatory Impact Analysis, as required by the UMRA.

This action is not subject to the requirements of Section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments.

F. Executive Order 13132: Federalism

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

In the spirit of Executive Order 13132, and consistent with EPA policy to promote communications between EPA and State and local governments, EPA specifically solicits comment on this proposed rules from State and local officials.

NHTSA notes that EPCA contains a provision (49 U.S.C. 32919(a)) that expressly preempts any State or local government from adopting or enforcing a law or regulation related to fuel economy standards or average fuel economy standards for automobiles covered by an average fuel economy standard under 49 U.S.C. Chapter 329. However, commercial medium- and heavy-duty on-highway vehicles and work trucks are not ''automobiles,'' as defined in 49 U.S.C. 32901(a)(3). In Phase 1 NHTSA concluded that EPCA's express preemption provision would not reach the fuel efficiency standards to be established in this rulemaking. NHTSA is reiterating that conclusion here for the proposed Phase 2 standards.

NHTSA also considered the issue of implied or conflict preemption. The possibility of such preemption is dependent upon there being an actual conflict between a standard established by NHTSA in this rulemaking and a State or local law or regulation. See *Spriestma* v. *Mercury Marine,* 537 U.S. 51, 64–65 (2002). At present, NHTSA has no knowledge of any State or local law or regulation that would actually conflict with one of the fuel efficiency standards to be established in this rulemaking.

NHTSA seeks public comment on this issue.

G. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

This action does not have tribal implications as specified in Executive Order 13175. This proposal will be implemented at the Federal level and impose compliance costs only on vehicle and engine manufacturers. Tribal governments would be affected only to the extent they purchase and use regulated vehicles. Thus, Executive Order 13175 does not apply to this action.

The agencies specifically solicit comment on this proposal from Tribal officials.

H. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

This action is subject to Executive Order 13045 because it is an economically significant regulatory action as defined by Executive Order 12866, and the agencies believe that the environmental health or safety risk addressed by this action may have a disproportionate effect on children. Accordingly, we have evaluated the environmental health or safety effects of these risks on children. The results of this evaluation are discussed below.

A synthesis of the science and research regarding how climate change may affect children and other vulnerable subpopulations is contained in the Technical Support Document for Endangerment or Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, which can be found in the public docket for this proposal. In making those findings, EPA Administrator placed weight on the fact that certain groups, including children, are particularly vulnerable to climate-related health effects. In those findings, EPA Administrator also determined that the health effects of climate change linked to observed and projected elevated concentrations of GHGs include the increased likelihood of more frequent and intense heat waves, increases in ozone concentrations over broad areas of the country, an increase of the severity of extreme weather events such as hurricanes and floods, and increasing severity of coastal storms due to rising sea levels. These effects can all increase mortality and morbidity, especially in vulnerable populations such as children, the elderly, and the poor. In addition, the occurrence of wildfires in North America have increased and are likely to intensify in a warmer future. PM emissions from these wildfires can contribute to acute and chronic illnesses of the respiratory system, including pneumonia, upper respiratory diseases, asthma, and chronic obstructive pulmonary disease, especially in children.

The agencies have estimated reductions in projected global mean surface temperature and sea level rise as a result of reductions in GHG emissions associated with the standards finalized in this action (Section VII and NHTSA's DEIS). Due to their vulnerability, children may receive disproportionate benefits from these reductions in temperature and the subsequent reduction of increased ozone and severity of weather events.

As discussed in Section VIII.D.2, based on the magnitude of the non-GHG co-pollutant emissions changes predicted to result from the proposed standards, the agencies expect that there will be improvements in ambient air quality, pending a more comprehensive analysis for the final rulemaking. Due to their vulnerability, children may receive disproportionate benefits from these reductions, as well.

Children are also more susceptible than adults to many air pollutants because of differences in physiology, higher per body weight breathing rates and consumption, rapid development of the brain and bodily systems, and behaviors that increase chances for exposure. Even before birth, the developing fetus may be exposed to air pollutants through the mother that affect development and permanently harm the individual.

Infants and children breathe at much higher rates per body weight than adults, with infants under one year of age having a breathing rate up to five times that of adults.[882] In addition, children breathe through their mouths more than adults and their nasal passages are less effective at removing pollutants, which leads to a higher deposition fraction in their lungs.[883]

Certain motor vehicle emissions present greater risks to children as well. Early lifestages (*e.g.,* children) are thought to be more susceptible to tumor development than adults when exposed to carcinogenic chemicals that act through a mutagenic mode of action.[884] Exposure at a young age to these carcinogens could lead to a higher risk of developing cancer later in life.

The adverse effects of individual air pollutants may be more severe for children, particularly the youngest age groups, than adults. The Integrated Science Assessments and Criteria Documents for a number of pollutants affected by these rules, including those for NO_2, SO_2, PM, ozone and CO, describe children as a group with greater susceptibility. Section VIII.B.7 discusses a number of childhood health outcomes associated with proximity to roadways, including evidence for exacerbation of asthma symptoms and suggestive evidence for new onset asthma. In general, these studies do not identify the specific contaminants associated with adverse effects, instead addressing the near-roadway environment as one containing numerous exposures potentially associated with adverse health effects.

There is substantial evidence that people who live or attend school near major roadways are more likely to be of a minority race, Hispanic ethnicity, and/or low SES. Within these highly exposed groups, children's exposure and susceptibility to health effects is greater than adults due to school-related and seasonal activities, behavior, and physiological factors.

Section VIII.D.2 describes the expected ambient air quality changes for non-GHG co-pollutants resulting from the proposed standards, which represent levels to which the general population is exposed. Children are not expected to experience greater ambient concentrations of air pollutants than the general population. However, because of their greater susceptibility to air pollution and their increased time spent outdoors, it is likely that the proposed standards would have particular benefits for children's health.

I. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use

This action is not a ''significant energy action'' because it is not likely to have a significant adverse effect on the supply, distribution or use of energy. In fact, this proposal has a positive effect on energy supply and use. Because the combination of the proposed fuel economy standards and the proposed GHG emission standards would result in significant fuel savings, this proposal encourages more efficient use of fuels. Therefore, we have concluded that this proposal is not likely to have any adverse energy effects. Our energy effects analysis is described above in Section IX.

J. National Technology Transfer and Advancement Act and 1 CFR Part 51

This action involves technical standards.

The agencies propose to use the following voluntary consensus standards from SAE International:

- SAE J1263 (March 2010) and SAE J2263 (December 2008) are voluntary consensus standards that together establish a test protocol to determine road-load coefficients for properly testing vehicles on a chassis dynamometer to simulate in-use operating conditions. Heavy-duty vehicle testing already relies on these reference standards under 40 CFR part 1066.
- SAE J2343 (July 2008). This voluntary consensus standard establishes a minimum hold time for LNG-fueled vehicles following a refueling event before the tank vents to relieve pressure. This is described further in Section XIII.A.3.

We are also aware that updated standards are pending for three SAE standards that are already incorporated by reference in the regulations—SAE J2263, SAE J1526, and SAE J2071. We will consider referencing these updated standards if they are adopted before completion of the final rule. All SAE documents are available from the publisher's Web site at *www.sae.org.*

We are proposing to adopt updated versions of two ASTM standards that already apply under 40 CFR part 1036. This applies for ASTM D240–14 and ASTM D4809–13, both of which specify test methods for determining the heat of combustion of liquid hydrocarbon fuels.

This action also involves technical standards for which there is no available voluntary consensus standard. First, the agencies are proposing greenhouse gas emission standards for heavy-duty vehicles that depend on computer modeling to predict and emission rate based on various engine and vehicle characteristics. Such a model is not available from other sources, so EPA has developed the Greenhouse Gas Emission Model as a simulation tool for demonstrating compliance with emission standards. See Section II for a detailed description of the model. A working version of this software is available for download at *http://www.epa.gov/otaq/climate/gem.htm.*

Second, we need to define a benchmark gear oil for establishing a reference point for establishing improvements in axle efficiency. There is no voluntary consensus standard for this purpose. As described in Section II.C.1.c, we are instead proposing to identify the technical specifications for a commonly used commercial product from BASF Corporation. These technical specifications have been placed in the docket for this rulemaking.

Third, 40 CFR part 1037 includes several test procedures involving calculation with numerous physical quantities. We are incorporating by reference NIST Special Publication 811 to allow for standardization and consistency of units and nomenclature. This standard, which already applies for

[882] U.S. Environmental Protection Agency. (2009). Metabolically-derived ventilation rates: a revised approach based upon oxygen consumption rates. Washington, DC: Office of Research and Development. EPA/600/R–06/129F. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=202543.*

[883] Foos, B.; Marty, M.; Schwartz, J.; Bennet, W.; Moya, J.; Jarabek, A.M.; Salmon, A.G. (2008) Focusing on children's inhalation dosimetry and health effects for risk assessment: An introduction. J Toxicol Environ Health 71A: 149–165.

[884] U.S. Environmental Protection Agency. (2005). Supplemental guidance for assessing susceptibility from early-life exposure to carcinogens. Washington, DC: Risk Assessment Forum. EPA/630/R–03/003F. *http://www.epa.gov/raf/publications/pdfs/childrens_supplement_final.pdf.*

40 CFR parts 1065 and 1066, is published by the National Institute of Standards and Technology (Department of Commerce) and is available at no charge at *www.nist.gov*.

Fourth, the amendments for marine diesel engines involve technical standards related to the requirements that apply internationally. There are no voluntary consensus documents that address these technical standards. In earlier rulemakings, EPA has adopted an incorporation by reference for MARPOL Annex VI and the NO_X Technical code in 40 CFR parts 1042 and 1043. The International Maritime Organization adopted changes to these documents in 2013 and 2014, which need to be reflected in 40 CFR parts 1042 and 1043. EPA recently adopted the updated reference documents in 40 CFR part 1043. As noted in Section XIV.H.4, this proposal includes the remaining step of incorporating the updated IMO documents by reference in 40 CFR part 1042. All these documents are available at *www.imo.org*.

K. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

The agencies believe the human health or environmental risk addressed by this action will not have potential disproportionately high and adverse human health or environmental effects on minority, low-income or indigenous populations. The results of this evaluation are discussed below.

With respect to GHG emissions, the agencies have determined that these proposed rules would not have disproportionately high and adverse human health or environmental effects on minority, low-income or indigenous populations because they increase the level of environmental protection for all affected populations without having any disproportionately high and adverse human health or environmental effects on any population, including any minority, low-income or indigenous population. The reductions in CO_2 and other GHGs associated with the standards would affect climate change projections, and the agencies have estimated reductions in projected global mean surface temperatures (Section VII). Within communities experiencing adverse impacts related to climate change, certain parts of the population may be especially vulnerable; these include the poor, the elderly, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources.[885]

For non-GHG co-pollutants such as ozone, $PM_{2.5}$, and toxics, the agencies have concluded that it is not practicable to determine whether there would be disproportionately high and adverse human health or environmental effects on minority, low income and/or indigenous populations from these rules. As discussed in Section VIII.D.2, however, based on the magnitude of the non-GHG co-pollutant emissions changes predicted to result from the proposed standards, EPA and NHTSA expect that there will be improvements in ambient air quality that would likely help in mitigating the disparity in racial, ethnic, and economically-based exposures, pending a more comprehensive analysis for the final rulemaking.

L. Endangered Species Act

Section 7(a)(2) of the ESA requires federal agencies, in consultation with one or both of the Services (depending on the species at issue), to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of federally listed endangered or threatened species or result in the destruction or adverse modification of designated critical habitat of such species. 16 U.S.C. 1536(a)(2). Under relevant implementing regulations, section 7(a)(2) applies only to actions where there is discretionary federal involvement or control. 50 CFR 402.03. Further, under the regulations consultation is required only for actions that ''may affect'' listed species or designated critical habitat. 50 CFR 402.14. Consultation is not required where the action has no effect on such species or habitat. Under this standard, it is the federal agency taking the action that evaluates the action and determines whether consultation is required. *See* 51 FR 19926, 19949 (June 3, 1986). Effects of an action include both the direct and indirect effects that will be added to the environmental baseline. 50 CFR 402.02. Indirect effects are those that are caused by the action, later in time, and that are reasonably certain to occur. *Id.* To trigger a consultation requirement, there must thus be a causal connection between the federal action, the effect in question, and the listed species, and the effect must be reasonably certain to occur.

[885] EPA 2009. Technical Support Document for Endangerment and Cause of Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act. Available at: *http://www.epa.gov/climatechange/Downloads/endangerment/Endangerment_TSD.pdf*.

The agencies note that the projected environmental effects of this rule are positive. See proposed preamble section VII.C and VIII. However, the fact that the rule will have overall positive effects on the environment does not mean that the rule may affect any listed species or designated critical habitat within the meaning of ESA section 7(a)(2) or the implementing regulations or require ESA consultation. We have carefully considered various types of potential effects in reaching the conclusion that ESA consultation is not required for this rule.

With respect to the projected GHG emission reductions, we are mindful of significant legal and technical analysis undertaken by FWS and the U.S. Department of the Interior in the context of listing the polar bear as a threatened species under the ESA. In that context, in 2008, FWS and DOI expressed the view that the best scientific data available were insufficient to draw a causal connection between GHG emissions and effects on the species in its habitat.[886] The DOI Solicitor concluded that where the effect at issue is climate change, proposed actions involving GHG emissions cannot pass the ''may affect'' test of the section 7 regulations and thus are not subject to ESA consultation.

The agencies have also previously considered issues relating to GHG emissions in connection with the requirements of ESA section 7(a)(2). Although the GHG emission reductions projected for this proposal are large, EPA evaluated comparable or larger reductions in assessing this same issue in the context of the light duty vehicle GHG emission standards for model years 2012–2016 and 2017–2025. There the agency projected emission reductions comparable to, or greater than those projected here over the lifetimes of the model years in question[887] and, based on air quality modeling of potential environmental effects, concluded that ''EPA knows of no modeling tool which can link these small, time-attenuated changes in global metrics to particular effects on listed species in particular areas. Extrapolating from global metric to local effect with

[886] *See, e.g.,* 73 FR 28212, 28300 (May 15, 2008); Memorandum from David Longly Bernhardt, Solicitor, U.S. Department of the Interior re: ''Guidance on the Applicability of the Endangered Species Act's Consultation Requirements to Proposed Actions Involving the Emission of Greenhouse Gases'' (Oct. 3, 2008).

[887] *See* 75 FR at 25347 Table I.C 2–4 (May 7, 2010); 77 FR at 62894 Table III–68 (Oct. 15, 2012); compare with Table VII–41 to the preamble to the proposed rule here. Projected emission reductions of criteria pollutants and air toxics are also on the same order as the two light duty vehicle rules.

such small numbers, and accounting for further links in a causative chain, remain beyond current modeling capabilities.'' EPA, *Light Duty Vehicle Greenhouse Gas Standards and Corporate Average Fuel Economy Standards,* Response to Comment Document for Joint Rulemaking at 4–102 (Docket EPA–OAR–HQ–2009–4782). EPA reached this conclusion after evaluating issues relating to potential improvements relevant to both temperature and oceanographic pH outputs. EPA's ultimate finding was that ''any potential for a specific impact on listed species in their habitats associated with these very small changes in average global temperature and ocean pH is too remote to trigger the threshold for ESA section 7(a)(2).''*Id.* EPA believes that the same conclusion would apply to the present proposed rule (should it be adopted), given that the projected CO_2 emission reductions are comparable to or less than those projected for either of the light duty vehicle rules. See section VII.D.2 and Table VII–41 to the preamble to the proposed rule; *See also, e.g., Ground Zero Center for Non-Violent Action* v. *U.S. Dept. of Navy,* 383 F. 3d 1082, 1091–92 (9th Cir. 2004) (where the likelihood of jeopardy to a species from a federal action is extremely remote, ESA does not require consultation).

XVI. EPA and NHTSA Statutory Authorities

As described below, the proposed regulations are authorized separately for EPA and NHTSA under the agencies' respective statutory authorities. See Section I for a discussion of these authorities.

A. EPA

Statutory authority for the vehicle controls proposed today is found in CAA section 202(a) (which authorizes standards for emissions of pollutants from new motor vehicles that emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare), and CAA sections 202(d), 203–209, 216, and 301 (42 U.S.C. 7521(a), 7521(d), 7522–7543, 7550, and 7601).

Pursuant to 42 U.S.C. 4365, EPA must make certain proposed rules available to the Science Advisory Board (SAB) for review. EPA may also voluntarily choose to make other rules available to the SAB. EPA notified the SAB of its plans for this rulemaking and on June 11, 2014, the chartered SAB discussed the recommendations of its work group on the planned action and agreed that no further SAB consideration of the supporting science was merited.

B. NHTSA

Statutory authority for the fuel consumption standards proposed today is found in section 103 of the Energy Independence and Security Act of 2007, 49 U.S.C. 32902(k). EISA authorizes a fuel efficiency improvement program, designed to achieve the maximum feasible improvement to be created for commercial medium- and heavy-duty on-highway vehicles and work trucks, to implement appropriate test methods, measurement metrics, fuel economy standards, and compliance and enforcement protocols that are appropriate, cost-effective and technologically feasible. To the extent motor vehicle safety is implicated, NHTSA's authority to regulate it is also derived from the National Traffic and Motor Vehicle Safety Act, 49 U.S.C. 30101 *et seq.*

List of Subjects

40 CFR Part 9

Reporting and recordkeeping requirements.

40 CFR Part 22

Administrative practice and procedure, Air pollution control, Hazardous substances, Hazardous waste, Penalties, Pesticides and pests, Poison prevention, Water pollution control.

40 CFR Part 85

Confidential business information, Imports, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Research, Warranties.

40 CFR Part 86

Administrative practice and procedure, Confidential business information, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 600

Administrative practice and procedure, Electric power, Fuel economy, Incorporation by reference, Labeling, Reporting and recordkeeping requirements.

40 CFR Part 1033

Administrative practice and procedure, Air pollution control.

40 CFR Parts 1036 and 1037

Environmental protection, Administrative practice and procedure, Air pollution control, confidential business information, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1039

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Penalties, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1042

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Penalties, Reporting and recordkeeping requirements, Vessels, Warranties.

40 CFR Part 1043

Environmental protection, Administrative practice and procedure, Air pollution control, Imports, Incorporation by reference, Vessels, Reporting and recordkeeping requirements.

40 CFR Parts 1065 and 1066

Administrative practice and procedure, Air pollution control, Incorporation by reference, Reporting and recordkeeping requirements, Research.

40 CFR Part 1068

Administrative practice and procedure, Confidential business information, Imports, Incorporation by reference, Motor vehicle pollution, Penalties, Reporting and recordkeeping requirements, Warranties.

49 CFR Part 512

Administrative practice and procedure, Confidential business information, Freedom of information, Motor vehicle safety, Reporting and recordkeeping requirements.

49 CFR Parts 523, 534, 535, and 537

Fuel economy, Reporting and recordkeeping requirements.

49 CFR Part 538

Administrative practice and procedure, Fuel economy, Motor vehicles, Reporting and recordkeeping requirements.

For the reasons set out in the preamble, title 40, chapter I of the Code of Federal Regulations is proposed to be amended as set forth below.

PART 9—OMB Approvals Under the Paperwork Reduction Act

■ 1. The authority citation for part 9 continues to read as follows:

Authority: 7 U.S.C. 135 *et seq.,* 136–136y; 15 U.S.C. 2001, 2003, 2005, 2006, 2601–2671; 21 U.S.C. 331j, 346a, 31 U.S.C. 9701; 33 U.S.C. 1251 *et seq.,* 1311, 1313d, 1314, 1318, 1321, 1326, 1330, 1342, 1344, 1345 (d) and (e), 1361; E.O. 11735, 38 FR 21243, 3 CFR, 1971–1975 Comp. p. 973; 42 U.S.C. 241, 242b, 243, 246, 300f, 300g, 300g–1, 300g–2, 300g–3, 300g–4, 300g–5, 300g–6, 300j–1, 300j–2, 300j–3, 300j–4, 300j–9, 1857 *et seq.,* 6901–6992k, 7401–7671q, 7542, 9601–9657, 11023, 11048.

■ 2. In § 9.1 the table is amended by:

■ a. Adding in numerical order by CFR designation a new undesignated center heading ''Control of Emissions from New and In-Use Heavy-Duty Highway Engines'' and its entry in numerical order for ''1036.825''.;

■ b. Adding in numerical order by CFR designation a new undesignated center heading ''Control of Emissions from New Heavy-Duty Motor Vehicles'' and its entry in numerical order for ''1037.825''.; and

■ c. Adding in numerical order by CFR designation a new undesignated center heading ''Control of NO_X SO_X, and PM Emissions from Marine Engines and Vessels Subject to the Marpol Protocol'' and its entryies in numerical order for ''1043.40—through 1043.95''.

The additions read as follows:

§ 9.1 OMB approvals under the Paperwork Reduction Act.

* * * * *

40 CFR citation	OMB Control No.
* * * * *	
Control of Emissions From New and In-Use Heavy-Duty Highway Engines	
1036.825	2060–0678
* * * * *	
Control of Emissions From New Heavy-Duty Motor Vehicles	
1037.825	2060–0678
* * * * *	
Control of NO_X SO_X, and PM Emissions From Marine Engines and Vessels Subject to the Marpol Protocol	
1043.40–1043.95	2060–0641
* * * * *	

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PART 22—CONSOLIDATED RULES OF PRACTICE GOVERNING THE ADMINISTRATIVE ASSESSMENT OF CIVIL PENALTIES AND THE REVOCATION/TERMINATION OR SUSPENSION OF PERMITS

■ 3. The authority citation for part 22 continues to read as follows:

Authority: 7 U.S.C. 136(l); 15 U.S.C. 2615; 33 U.S.C. 1319, 1342, 1361, 1415 and 1418; 42 U.S.C. 300g–3(g), 6912, 6925, 6928, 6991e and 6992d; 42 U.S.C. 7413(d), 7524(c), 7545(d), 7547, 7601 and 7607(a), 9609, and 11045.

■ 4. Section 22.1 is amended by revising paragraph (a)(2) to read as follows:

§ 22.1 Scope of this part.

(a) * * *

(2) The assessment of any administrative civil penalty under sections 113(d), 205(c), 211(d) and 213(d) of the Clean Air Act, as amended (42 U.S.C. 7413(d), 7524(c), 7545(d) and 7547(d)), and a determination of nonconforming engines, vehicles or equipment under sections 207(c) and 213(d) of the Clean Air Act, as amended (42 U.S.C. 7541(c) and 7547(d));

* * * * *

■ 5. Section 22.34 is revised to read as follows:

§ 22.34 Supplemental rules governing the administrative assessment of civil penalties under the Clean Air Act.

(a) *Scope.* This section shall apply, in conjunction with §§ 22.1 through 22.32, in administrative proceedings to assess a civil penalty conducted under sections 113(d), 205(c), 211(d), and 213(d) of the Clean Air Act, as amended (42 U.S.C. 7413(d), 7524(c), 7545(d), and 7547(d)), and a determination of nonconforming engines, vehicles or equipment under sections 207(c) and 213(d) of the Clean Air Act, as amended (42 U.S.C. 7541(c) and 7547(d)). Where inconsistencies exist between this section and §§ 22.1 through 22.32, this section shall apply.

(b) *Issuance of notice.* Prior to the issuance of a final order assessing a civil penalty or a final determination of nonconforming engines, vehicles or equipment, the person to whom the order or determination is to be issued shall be given written notice of the proposed issuance of the order or determination. Service of a complaint or a consent agreement and final order pursuant to § 22.13 satisfies these notice requirements.

PART 85—CONTROL OF AIR POLLUTION FROM MOBILE SOURCES

■ 6. The authority citation for part 85 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart F—Exemption of Clean Alternative Fuel Conversions From Tampering Prohibition

■ 7. Section 85.525 is revised to read as follows:

§ 85.525 Applicable standards.

To qualify for an exemption from the tampering prohibition, vehicles/engines that have been converted to operate on a different fuel must meet emission standards and related requirements as described in this section. The modified vehicle/engine must meet the requirements that applied for the OEM vehicle/engine, or the most stringent OEM vehicle/engine standards in any allowable grouping. Fleet average standards do not apply unless clean alternative fuel conversions are specifically listed as subject to the standards.

(a) If the vehicle/engine was certified with a Family Emission Limit for NO_X, NO_X + HC, NO_X + NMOG, or particulate matter, as noted on the vehicle/engine emission control information label, the modified vehicle/engine may not exceed this Family Emission Limit.

(b) Compliance with greenhouse gas emission standards is demonstrated as follows:

(1) Subject to the following exceptions and special provisions, compliance with light-duty vehicle greenhouse gas

emission standards is demonstrated by complying with the N_2O and CH_4 standards and provisions set forth in 40 CFR 86.1818–12(f)(1) and the in-use CO_2 exhaust emission standard set forth in 40 CFR 86.1818–12(d) as determined by the OEM for the subconfiguration that is identical to the fuel conversion emission data vehicle (EDV):

(i) If the OEM complied with the light-duty greenhouse gas standards using the fleet averaging option for N_2O and CH_4, as allowed under 40 CFR 86.1818–12(f)(2), the calculations of the carbon-related exhaust emissions require the input of grams/mile values for N_2O and CH_4, and you are not required to demonstrate compliance with the standalone CH_4 and N_2O standards.

(ii) If the OEM complied with alternate standards for N_2O and/or CH_4, as allowed under 40 CFR 86.1818–12(f)(3), you may demonstrate compliance with the same alternate standards.

(iii) If the OEM complied with the nitrous oxide (N_2O) and methane (CH_4) standards and provisions set forth in 40 CFR 86.1818–12(f)(1) or (f)(3), and the fuel conversion CO_2 measured value is lower than the in-use CO_2 exhaust emission standard, you also have the option to convert the difference between the in-use CO_2 exhaust emission standard and the fuel conversion CO_2 measured value into GHG equivalents of CH_4 and/or N_2O, using 298 g CO_2 to represent 1 g N_2O and 25 g CO_2 to represent 1 g CH_4. You may then subtract the applicable converted values from the fuel conversion measured values of CH_4 and/or N_2O to demonstrate compliance with the CH_4 and/or N_2O standards.

(iv) Optionally, compliance with greenhouse gas emission requirements may be demonstrated by comparing emissions from the vehicle prior to the fuel conversion to the emissions after the fuel conversion. This comparison must be based on FTP test results from the emission data vehicle (EDV) representing the pre-conversion test group. The sum of CO_2, CH_4, and N_2O shall be calculated for pre- and post-conversion FTP test results, where CH_4 and N_2O are weighted by their global warming potentials of 25 and 298, respectively. The post-conversion sum of these emissions must be lower than the pre-conversion conversion greenhouse gas emission results. CO_2 emissions are calculated as specified in 40 CFR 600.113–12. If statements of compliance are applicable and accepted in lieu of measuring N_2O, as permitted by EPA regulation, the comparison of the greenhouse gas results also need not measure or include N_2O in the before and after emission comparisons.

(2) Compliance with heavy-duty engine greenhouse gas emission standards is demonstrated by complying with the CO_2, N_2O, and CH_4 standards (or FELs, as applicable) and provisions set forth in 40 CFR 1036.108 for the engine family that is represented by the fuel conversion emission data engine (EDE). The following additional provisions apply:

(i) If the fuel conversion CO_2 measured value is lower than the CO_2 standard (or FEL, as applicable), you have the option to convert the difference between the CO_2 standard (or FEL, as applicable) and the fuel conversion CO_2 measured value into GHG equivalents of CH_4 and/or N_2O, using 298 g/hp-hr CO_2 to represent 1 g/hp-hr N_2O and 25 g/hp-hr CO_2 to represent 1 g/hp-hr CH_4. You may then subtract the applicable converted values from the fuel conversion measured values of CH_4 and/or N_2O to demonstrate compliance with the CH_4 and/or N_2O standards (or FEL, as applicable).

(ii) Small volume conversion manufacturers may demonstrate compliance with N_2O standards based on an engineering analysis.

(iii) For conversions of engines installed in vocational vehicles subject to Phase 2 standards under 40 CFR 1037.105 or in tractors subject to Phase 2 standards under 40 CFR 1037.106, conversion manufacturers may omit a demonstration related to the vehicle-based standards, as long as they have a reasonable technical basis for believing that the modified vehicle continues to meet those standards.

(3) Subject to the following exceptions and special provisions, compliance with greenhouse gas emission standards for heavy-duty vehicles subject to 40 CFR 1037.104 is demonstrated by complying with the N_2O and CH_4 standards and provisions set forth in 40 CFR 1037.104 and the in-use CO_2 exhaust emission standard set forth in 40 CFR 1037.104(b) as determined by the OEM for the subconfiguration that is identical to the fuel conversion emission data vehicle (EDV):

(i) If the OEM complied with alternate standards for N_2O and/or CH_4, as allowed under 40 CFR 1037.104(c) you may demonstrate compliance with the same alternate standards.

(ii) If you are unable to meet either the N_2O or CH_4 standards and your fuel conversion CO_2 measured value is lower than the in-use CO_2 exhaust emission standard, you may also convert the difference between the in-use CO_2 exhaust emission standard and the fuel conversion CO_2 measured value into GHG equivalents of CH_4 and/or N_2O, using 298 g CO_2 to represent 1 g N_2O, and 25 g CO_2 to represent 1 g CH_4. You may then subtract the applicable converted values from the fuel conversion measured values of CH_4 and/or N_2O to demonstrate compliance with the CH_4 and/or N_2O standards.

(iii) You may alternatively comply with the greenhouse gas emission requirements by comparing emissions from the vehicle before and after the fuel conversion. This comparison must be based on FTP test result from the emission data vehicle (EDV) representing the pre-conversion test group. The sum of CO_2, CH_4, and N_2O shall be calculated for pre- and post-conversion FTP test results, where CH_4 and N_2O are weighted by their global warming potentials of 25 and 298, respectively. The post-conversion sum of these emissions must be lower than the pre-conversion greenhouse gas emission result. Calculate CO_2 emissions as specified in 40 CFR 600.113. If we waive N_2O measurement requirements based on a statement of compliance, disregard N_2O for all measurements and calculations under this paragraph (b)(3)(iii).

(c) Conversion systems for engines that would have qualified for chassis certification at the time of OEM certification may use those procedures, even if the OEM did not. Conversion manufacturers choosing this option must designate test groups using the appropriate criteria as described in this subpart and meet all vehicle chassis certification requirements set forth in 40 CFR part 86, subpart S.

Subpart O—Urban Bus Rebuild Requirements

■ 8. Section 85.1406 is amended by revising paragraph (f)(2) to read as follows:

§ 85.1406 Certification.

* * * * *

(f) * * *

(2) If the equipment certifier disagrees with such determination of nonconformity and so advises the Agency, the Administrator shall afford the equipment certifier and other interested persons an opportunity to present their views and evidence in support thereof at a public hearing conducted in accordance with procedures found in 40 CFR part 1068, subpart G.

Subpart P—Importation of Motor Vehicles And Motor Vehicle Engines

■ 9. Section 85.1508 is amended by revising paragraph (c) to read as follows:

§ 85.1508 ''In Use'' inspections and recall requirements.

* * * * *

(c) A certificate holder will be notified whenever the Administrator has determined that a substantial number of a class or category of the certificate holder's vehicles or engines, although properly maintained and used, do not conform to the regulations prescribed under section 202 when in actual use throughout their useful lives (as determined under section 202(d)). After such notification, the Recall Regulations at 40 CFR part 1068, subpart G, shall govern the certificate holder's responsibilities and references to a manufacturer in the Recall Regulations shall apply to the certificate holder.

■ 10. Section 85.1513 is amended by revising paragraph (e)(4) to read as follows:

§ 85.1513 Prohibited acts; penalties.

* * * * *

(e) * * *

(4) Hearings on suspensions and revocations of certificates of conformity or of eligibility to perform modification/testing under § 85.1509 shall be held in accordance with 40 CFR part 1068, subpart G.

* * * * *

Subpart R—Exclusion and Exemption of Motor Vehicles and Motor Vehicle Engines

■ 11. Section 85.1701 is amended by revising paragraph (a)(1) to read as follows:

§ 85.1701 General applicability.

(a) * * *

(1) Beginning January 1, 2014, the exemption provisions of 40 CFR part 1068, subpart C, apply instead of the provisions of this subpart for heavy-duty motor vehicle engines regulated under 40 CFR part 86, subpart A, except that the competition exemption of 40 CFR 1068.235 and the hardship exemption provisions of 40 CFR 1068.245, 1068.250, and 1068.255 do not apply for motor vehicle engines.

* * * * *

■ 12. Section 85.1703 is amended by adding paragraph (b) to read as follows:

§ 85.1703 Definition of motor vehicle.

* * * * *

(b) Note that, in applying the criterion in paragraph (a)(2) of this section, vehicles that are clearly intended for operation on highways are motor vehicles. Absence of a particular safety feature is relevant only when absence of that feature would prevent operation on highways.

■ 13. Section 85.1706 is amended by revising paragraph (b) to read as follows:

§ 85.1706 Pre-certification exemption.

* * * * *

(b) Any manufacturer that desires a pre-certification exemption and is in the business of importing, modifying or testing uncertified vehicles for resale under the provisions of 40 CFR 85.1501, *et seq.,* must send the request to the Designated Compliance Officer as specified in 40 CFR 1068.30. The Designated Compliance Officer may require such manufacturers to submit information regarding the general nature of the fleet activities, the number of vehicles involved, and a demonstration that adequate record-keeping procedures for control purposes will be employed.

§§ 85.1713 and 85.1714 [Removed]

■ 14. Remove §§ 85.1713 and 85.1714.

Subpart S—Recall Regulations

■ 15. Subpart S is revised to read as follows:

Subpart S—Recall Regulations

§ 85.1801 Recall regulations.

Recall regulations apply for motor vehicles and motor vehicle engines as specified in 40 CFR part 1068, subpart G.

Subpart T—Emission Defect Reporting Requirements

■ 16. Section 85.1901 is revised to read as follows:

§ 85.1901 Applicability.

(a) The requirements of this subpart shall be applicable to all 1972 and later model year motor vehicles and motor vehicle engines, except that the provisions of 40 CFR 1068.501 apply instead for heavy-duty motor vehicle engines certified under 40 CFR part 86, subpart A, and for heavy-duty motor vehicles certified under 40 CFR part 1037 starting January 1, 2018.

(b) The requirement to report emission-related defects affecting a given class or category of vehicles or engines shall remain applicable for five years from the end of the model year in which such vehicles or engines were manufactured.

■ 17. Section 85.1902 is revised to read as follows:

§ 85.1902 Definitions.

For the purposes of this subpart and unless otherwise noted:

(a) *Act* means the Clean Air Act, 42 U.S.C. 7401–7671q, as amended.

(b) *Emission-related defect* means:

(1) A defect in design, materials, or workmanship in a device, system, or assembly described in the approved Application for Certification that affects any parameter or specification enumerated in appendix VIII of this part; or

(2) A defect in the design, materials, or workmanship in one or more emission-related parts, components, systems, software or elements of design which must function properly to ensure continued compliance with emission standards.

(c) *Useful life* has the meaning given in section 202(d) of the Act (42 U.S.C. 7521(d)) and regulations promulgated thereunder.

(d) *Voluntary emissions recall* means a repair, adjustment, or modification program voluntarily initiated and conducted by a manufacturer to remedy any emission-related defect for which direct notification of vehicle or engine owners has been provided, including programs to remedy defects related to emissions standards for CO_2, CH_4, N_2O, and/or carbon-related exhaust emissions.

(e) U*ltimate purchaser* has the meaning given in section 216 of the Act (42 U.S.C. 7550).

(f) *Manufacturer* has the meaning given in section 216 of the Act (42 U.S.C. 7550).

PART 86—CONTROL OF EMISSIONS FROM NEW AND IN-USE HIGHWAY VEHICLES AND ENGINES

■ 18. The authority citation for part 86 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart A—General Provisions for Heavy-Duty Engines and Heavy-Duty Vehicles

■ 19. Revise the heading of subpart A to read as set forth above.

§ 86.001–35 [Removed]

■ 20. Remove § 86.001–35.

■ 21. Section 86.004–2 is amended by revising the definition of ''Emergency vehicle'' to read as follows:

§ 86.004–2 Definitions.

* * * * *

Emergency vehicle has the meaning given in 40 CFR 1037.801.

* * * * *

■ 22. Section 86.004–25 is amended by revising paragraph (b)(4)(i) to read as follows:

§ 86.004–25 Maintenance.

* * * * *

(b) * * *

(4) * * *

(i) For diesel-cycle heavy-duty engines, the adjustment, cleaning, repair, or replacement of the following items shall occur at 50,000 miles (or 1,500 hours) of use and at 50,000-mile (or 1,500-hour) intervals thereafter:

(A) Exhaust gas recirculation system related filters and coolers.

(B) Positive crankcase ventilation valve.

(C) Fuel injector tips (cleaning only).

(D) DEF filters.

* * * * *

■ 23. Section 86.004–28 is amended by revising paragraph (i) introductory text and adding paragraph (j) to read as follows:

§ 86.004–28 Compliance with emission standards.

* * * * *

(i) This paragraph (i) describes how to adjust emission results from model year 2020 and earlier heavy-duty engines equipped with exhaust aftertreatment to account for regeneration events. This provision only applies for engines equipped with emission controls that are regenerated on an infrequent basis. For the purpose of this paragraph (i), the term ''regeneration'' means an event during which emission levels change while the aftertreatment performance is being restored by design. Examples of regenerations are increasing exhaust gas temperature to remove sulfur from an adsorber or increasing exhaust gas temperature to oxidize PM in a trap. For the purpose of this paragraph (i), the term ''infrequent'' means having an expected frequency of less than once per transient test cycle. Calculation and use of adjustment factors are described in paragraphs (i)(1) through (5) of this section. If your engine family includes engines with one or more AECDs for emergency vehicle applications approved under paragraph (4) of the definition of defeat device in § 86.004–2, do not consider additional regenerations resulting from those AECDs when calculating emission factors or frequencies under this paragraph (i).

* * * * *

(j) For model year 2021 and later engines using aftertreatment technology with infrequent regeneration events that may occur during testing, take one of the following approaches to account for the emission impact of regeneration:

(1) You may use the calculation methodology described in 40 CFR 1065.680 to adjust measured emission results. Do this by developing an upward adjustment factor and a downward adjustment factor for each pollutant based on measured emission data and observed regeneration frequency as follows:

(i) Adjustment factors should generally apply to an entire engine family, but you may develop separate adjustment factors for different configurations within an engine family. Use the adjustment factors from this section for all testing for the engine family.

(ii) You may use carryover or carry-across data to establish adjustment factors for an engine family as described in § 86.001–24(f), consistent with good engineering judgment.

(iii) Identify the value of *F* in each application for the certification for which it applies.

(2) You may ask us to approve an alternate methodology to account for regeneration events. We will generally limit approval to cases where your engines use aftertreatment technology with extremely infrequent regeneration and you are unable to apply the provisions of this section.

(3) You may choose to make no adjustments to measured emission results if you determine that regeneration does not significantly affect emission levels for an engine family (or configuration) or if it is not practical to identify when regeneration occurs. If you choose not to make adjustments under paragraph (j)(1) or (2) of this section, your engines must meet emission standards for all testing, without regard to regeneration.

§ 86.004–30—[Removed]

■ 24. Remove § 86.004–30.

■ 25. Section 86.007–11 is amended by revising paragraphs (a)(1)(iii), (c), and (g) to read as follows:

§ 86.007–11 Emission standards and supplemental requirements for 2007 and later model year diesel heavy-duty engines and vehicles.

* * * * *

(a)(1) * * *

(iii) Carbon monoxide. 15.5 grams per brake horsepower-hour (5.77 grams per megajoule).

* * * * *

(c) No crankcase emissions shall be discharged directly into the ambient atmosphere from any new 2007 or later model year diesel-cycle HDE, with the following exception: Diesel-fueled HDEs equipped with turbochargers, pumps, blowers, or superchargers for air induction may discharge crankcase emissions to the ambient atmosphere if the emissions are added to the exhaust emissions (either physically or mathematically) during all emission testing. Manufacturers taking advantage of this exception must manufacture the engines so that all crankcase emission can be routed into a dilution tunnel (or other sampling system approved in advance by the Administrator), and must account for deterioration in crankcase emissions when determining exhaust deterioration factors. For the purpose of this paragraph (c), crankcase emissions that are routed to the exhaust upstream of exhaust aftertreatment during all operation are not considered to be ''discharged directly into the ambient atmosphere.''

* * * * *

(g) Model year 2018 and later engines at or above 56 kW that will be installed in specialty vehicles as allowed by 40 CFR 1037.605 may meet alternate emission standards as follows:

(1) The engines must be of a configuration that is identical to one that is certified under 40 CFR part 1039.

(2) Except as specified in this paragraph (g), engines certified under this paragraph (g) must meet all the requirements that apply under 40 CFR part 1039 instead of the comparable provisions in this subpart A. In your annual production report, count these engines separately and identify the vehicle manufacturers that will be installing them. Treat these engines as part of the corresponding engine family under 40 CFR part 1039 for compliance purposes such as selective enforcement audits, in-use testing, defect reporting, and recall.

(3) The engines must be labeled as described in § 86.095–35. Engines certified under this paragraph (g) may not have the label specified for nonroad engines in 40 CFR part 1039.

(4) In a separate application for a certificate of conformity, identify the corresponding nonroad engine family, describe the label required under this paragraph (g), state that you meet applicable diagnostic requirements under 40 CFR part 1039, and identify your projected U.S.-directed production volume.

(5) No additional certification fee applies for engines certified under this paragraph (g).

(6) Engines certified under this paragraph (g) may not generate or use emission credits under this part or under 40 CFR part 1039. The vehicles in which these engines are installed may generate or use emission credits as described in 40 CFR part 1037.

* * * * *

§ 86.007–30 [Amended]

■ 26. Section 86.007–30 is amended by removing and reserving paragraph (d).

§ 86.007–35 [Removed]

■ 27. Remove § 86.007–35.

■ 28. Section 86.008–10 is amended by:
■ a. Revising paragraph (a)(1)(iii);
■ b. Removing and reserving paragraph (f); and
■ c. Revising paragraph (g).

The revisions read as follows:

§ 86.008–10 Emission standards for 2008 and later model year Otto-cycle heavy-duty engines and vehicles.

(a)(1) * * *

(iii) Carbon monoxide. 14.4 grams per brake horsepower-hour (5.36 grams per megajoule).

* * * * *

(g) Model year 2018 and later engines that will be installed in specialty vehicles as allowed by 40 CFR 1037.605 may meet alternate emission standards as follows:

(1) The engines must be of a configuration that is identical to one that is certified under 40 CFR part 1048 to the Blue Sky standards under 40 CFR 1048.140.

(2) Except as specified in this paragraph (g), engines certified under this paragraph (g) must meet all the requirements that apply under 40 CFR part 1048 instead of the comparable provisions in this subpart A. In your annual production report, count these engines separately and identify the vehicle manufacturers that will be installing them. Treat these engines as part of the corresponding engine family under 40 CFR part 1048 for compliance purposes such as production-line testing, in-use testing, defect reporting, and recall.

(3) The engines must be labeled as described in § 86.095–35. Engines certified under this paragraph (g) may not have the label specified for nonroad engines in 40 CFR part 1048.

(4) In a separate application for a certificate of conformity, identify the corresponding nonroad engine family, describe the label required under this paragraph (g), state that you meet applicable diagnostic requirements under 40 CFR part 1048, and identify your projected U.S.-directed production volume.

(5) No additional certification fee applies for engines certified under this paragraph (g).

(6) Engines certified under this paragraph (g) may not generate or use emission credits under this part. The vehicles in which these engines are installed may generate or use emission credits as described in 40 CFR part 1037.

■ 29. Section 86.078–6 is revised to read as follows:

§ 86.078–6 Hearings on certification.

If a manufacturer's request for a hearing is approved, EPA will follow the hearing procedures specified in 40 CFR part 1068, subpart G.

■ 30. Section 86.084–4 is revised to read as follows:

§ 86.084–4 Section numbering; construction.

(a) The model year of initial applicability is indicated by the last two digits of the 5-digit group. A section remains in effect for subsequent model years until it is superseded. The number following the hyphen designates what previous section is replaced by a future regulation. For example, § 86.005–1 applies to model year 2005 and later vehicles and engines until it is superseded. Section 86.016–1 takes effect with model year 2016 and continues to apply until it is superseded; § 86.005–1 no longer applies starting with model year 2016, except as specified by § 86.016–1.

(b) If the regulation references a section that has been superseded or no longer exists, this should be understood as a reference to the same section for the appropriate model year. For example, if the regulation refers to § 86.001–30, it should be taken as a reference to § 86.007–30 or any later version of that section that applies for the appropriate model year. However, this does not apply if the reference to a superseded section specifically states that the older provision applies instead of any updated provisions from the section in effect for the current model year; this occurs most often as part of the transition to new emission standards.

(c) Except where indicated, the language in this subpart applies to both vehicles and engines. In many instances, language referring to engines is enclosed in parentheses and immediately follows the language discussing vehicles.

§ 86.085–37 [Amended]

■ 31. Section 86.085–37 is amended by removing paragraph (d).

§ 86.094–30 [Removed]

■ 32. Remove § 86.094–30.

■ 33. Section 86.095–35 is amended by:
■ a. Revising paragraphs (a) introductory text, (a)(3)(iii)(B), (a)(3)(iii)(H), (I), (J), and (K);
■ b. Adding paragraph (c); and
■ c. Revising paragraph, (i).

The revisions and additions read as follows:

§ 86.095–35 Labeling.

(a) The manufacturer of any motor vehicle (or motor vehicle engine) subject to the applicable emission standards (and family emission limits, as appropriate) of this subpart, shall, at the time of manufacture, affix a permanent legible label, of the type and in the manner described below, containing the information hereinafter provided, to all production models of such vehicles (or engines) available for sale to the public and covered by a Certificate of Conformity under § 86.007–30(a).

* * * * *

(3) * * *

(iii) * * *

(B) The full corporate name and trademark of the manufacturer; though the label may identify another company and use its trademark instead of the manufacturer's as long as the manufacturer complies with the branding provisions of 40 CFR 1068.45.

* * * * *

(H) The prominent statement: ''This engine conforms to U.S. EPA regulations applicable to XXXX Model Year New Heavy-Duty Engines.'';

(I) If the manufacturer has an alternate useful life period under the provisions of § 86.094–21(f), the prominent statement: ''This engine has been certified to meet U.S. EPA standards for a useful-life period of XXX miles or XXX hours of operation, whichever occurs first. This engine's actual life may vary depending on its service application.'' The manufacturer may alter this statement only to express the assigned alternate useful life in terms other than miles or hours (*e.g.,* years, or hours only);

(J) For diesel engines, the prominent statement: ''This engine has a primary intended service application as a XXX heavy-duty engine.'' (The primary intended service applications are light, medium, and heavy, as defined in § 86.090–2.);

(K) For engines certified under the alternative standards specified in § 86.007–11(g) or § 86.008–10(g), the following statement: ''This engine is certified for only in specialty vehicles as specified in [40 CFR 86.007–11 or 40 CFR 86.008–10]'';

* * * * *

(c) Vehicles powered by model year 2007 through 2013 diesel-fueled engines must include permanent, readily visible labels on the dashboard (or instrument panel) and near all fuel inlets that state ''Use Ultra Low Sulfur Diesel Fuel Only''; or ''Ultra Low Sulfur Diesel Fuel Only''.

* * * * *

(i) The Administrator may approve in advance other label content and formats, provided the alternative label contains information consistent with this section.

Subpart E—Emission Regulations for 1978 and Later New Motorcycles, General Provisions

■ 34. Section 86.402–78 is amended by adding in alphabetical order a definition for ''Round'' to paragraph (a) to read as follows:

§ 86.402–78 Definitions.

(a) * * *

Round has the meaning given in 40 CFR 1065.1001, unless otherwise specified.

* * * * *

■ 35. Section 86.410–2006 is amended by revising paragraph (e) introductory text to read as follows:

§ 86.410–2006 Emission standards for 2006 and later model year motorcycles.

* * * * *

(e) Manufacturers with fewer than 500 employees worldwide and producing fewer than 3,000 motorcycles per year for the United States are considered small-volume manufacturers for the purposes of this section. The following provisions apply for these small-volume manufacturers:

* * * * *

§ 86.419–78 [Removed]

■ 36. Section 86.419–78 is removed.

■ 37. Section 86.419–2006 is amended by revising paragraph (a)(1) to read as follows:

§ 86.419–2006 Engine displacement, motorcycle classes.

(a)(1) Engine displacement shall be calculated using nominal engine values and rounded to the nearest whole cubic centimeter.

* * * * *

■ 38. Section 86.432–78 is amended by revising paragraph (d) to read as follows:

§ 86.432–78 Deterioration factor.

* * * * *

(d) An exhaust emission deterioration factor will be calculated by dividing the predicted emissions at the useful life distance by the predicted emissions at the total test distance. Predicted emissions are obtained from the correlation developed in paragraph (c) of this section. Factor = Predicted total distance emissions ÷ Predicted total test distance emissions. These interpolated and extrapolated values shall be carried out to four places to the right of the decimal point before dividing one by the other to determine the deterioration factor. The results shall be rounded to three places to the right of the decimal point.

* * * * *

■ 39. Section 86.443–78 is revised to read as follows:

§ 86.443–78 Request for hearing.

The manufacturer may request a hearing on the Administrator's determination as described in 40 CFR part 1068, subpart G.

■ 40. Section 86.444–78 is revised to read as follows:

§ 86.444–78 Hearings on certification.

If a manufacturer's request for a hearing is approved, EPA will follow the hearing procedures specified in 40 CFR part 1068, subpart G.

Subpart F—Emission Regulations for 1978 and Later New Motorcycles; Test Procedures

■ 41. Section 86.544–90 is amended by revising the introductory text and paragraph (a) to read as follows:

§ 86.544–90 Calculations; exhaust emissions.

This section describes how to calculate exhaust emissions. Determine emission results for each pollutant to at least one more decimal place than the applicable standard. Apply the deterioration factor, then round the adjusted figure to the same number of decimal places as the emission standard. Compare the rounded emission levels to the emission standard for each emission data vehicle. In the case of NO_X + HC standards, apply the deterioration factor to each pollutant and then add the results before rounding.

(a) Calculate a composite FTP emission result using the following equation:

$$Y_{wm} = 0.43 \cdot \frac{Y_{ct} + Y_s}{D_{ct} + D_s} + 0.57 \cdot \frac{Y_{ht} + Y_s}{D_{ht} + D_s}$$

Where:

Y_{wm} = Weighted mass emissions of each pollutant (*i.e.,* CO_2, HC, CO, or NO_X) in grams per vehicle kilometer and if appropriate, the weighted carbon mass equivalent of total hydrocarbon equivalent, in grams per vehicle kilometer.

Y_{ct} = Mass emissions as calculated from the transient phase of the cold-start test, in grams per test phase.

Y_s = Mass emissions as calculated from the stabilized phase of the cold-start test, in grams per test phase.

D_{ct} = The measured driving distance from the transient phase of the cold-start test, in kilometers.

D_s = The measured driving distance from the stabilized phase of the cold-start test, in kilometers.

Y_{ht} = Mass emissions as calculated from the transient phase of the hot-start test, in grams per test phase.

D_{ht} = The measured driving distance from the transient phase of the hot-start test, in kilometers.

* * * * *

Subpart G—Selective Enforcement Auditing of New Light-Duty Vehicles, Light-Duty Trucks, and Heavy-Duty Vehicles

■ 42. Section 86.614–84 is revised to read as follows:

§ 86.614–84 Hearings on suspension, revocation, and voiding of certificates of conformity.

The provisions of 40 CFR part 1068, subpart G, apply if a manufacturer requests a hearing regarding suspension, revocation or voiding of certificates of conformity.

■ 43. Section 86.615–84 is revised to read as follows:

§ 86.615–84 Treatment of confidential information.

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

Subpart L—Nonconformance Penalties for Gasoline-Fueled and Diesel Heavy-Duty Engines and Heavy-Duty Vehicles, Including Light-Duty Trucks

§ 86.1103–87 [Removed]

■ 44. Section 86.1103–87 is removed.

■ 45. Section 86.1103–2016 is added to subpart L to read as follows:

§ 86.1103–2016 Criteria for availability of nonconformance penalties.

(a) *General.* This section describes the three criteria EPA will use to use to evaluate whether NCPs are appropriate under the Clean Air Act for a given pollutant and a given subclass of heavy-duty engines and heavy-duty vehicles.

Together, these criteria evaluate the likelihood that a manufacturer will be technologically unable to meet a standard on time. Note that since the first two of these criteria are intended to address the question of whether a given standard creates the possibility for this to occur, they are evaluated before the third criterion that addresses the likelihood that the possibility will actually happen.

(b) *Criteria.* We will establish NCPs for a given pollutant and subclass when we find that each of the following criteria is met:

(1) There is a new or revised emission standard that is more stringent than the previous standard for the pollutant, or an existing standard for that pollutant has become more difficult to achieve because of a new or revised standard. When evaluating this criterion, EPA will consider a new or revised standard to be ''new'' or ''revised'' until the point at which all manufacturers already producing U.S.-directed engines or vehicles within the subclass have achieved full compliance with the standard. For purposes of this criterion, EPA will generally not consider compliance using banked emission credits to be ''full compliance''.

(2) Substantial work is required to meet the standard for which the NCP is offered, as evaluated from the point at which the standard was adopted or revised (or the point at which the standard became more difficult meet because another standard was adopted or revised). Substantial work, as used in this paragraph (b)(2), means the application of technology not previously used in an engine or vehicle class or subclass, or the significant modification of existing technology or design parameters, needed to bring the vehicle or engine into compliance with either the more stringent new or revised standard or an existing standard which becomes more difficult to achieve because of a new or revised standard. Note that where this criterion is evaluated after the work has been completed, the criterion would be interpreted as whether or not substantial work was required to meet the standard.

(3) There is or is likely to be a technological laggard for the subclass. Note that a technological laggard is a manufacturer that is unable to meet the standard for one or more products within the subclass for technological reasons.

(c) *Evaluation.* (1) We will generally evaluate these criteria in sequence. Where we find that the first criterion has not been met, we will not consider the other two criteria. Where we find that the first criterion has been met but not the second, we will not consider the third criterion. We may announce our findings separately or simultaneously.

(2) We may consider any available information in making our findings.

(3) Where we are uncertain whether the first and/or second criteria have been met, we may presume that they have been met and make our decision based solely on whether or not the third criterion has been met.

(4) Where we find that a manufacturer will fail to meet a standard but are uncertain whether the failure is a technological failure, we may presume that the manufacturer is a technological laggard.

§ 86.1104–91 [Removed]

■ 46. Section 86.1104–91 is removed.

■ 47. Section 86.1104–2016 is added to subpart L to read as follows:

§ 86.1104–2016 Determination of upper limits.

EPA shall set a separate upper limit for each phase of NCPs and for each service class.

(a) Except as provided in paragraphs (b), (c) and (d) of this section, the upper limit shall be set as follows:

(1) The upper limit applicable to a pollutant emission standard for a subclass of heavy-duty engines or heavy-duty vehicles for which an NCP is established in accordance with § 86.1103–87, shall be the previous pollutant emission standard for that subclass.

(2) If a manufacturer participates in any of the emissions averaging, trading, or banking programs, and carries over certification of an engine family from the prior model year, the upper limit for that engine family shall be the family emission limit of the prior model year, unless the family emission limit is less than the upper limit determined in paragraph (a)(1) of this section.

(b) If no previous standard existed for the pollutant under paragraph (a) of this section, the upper limit will be developed by EPA during rulemaking.

(c) EPA may set the upper limit during rulemaking at a level below the level specified in paragraph (a) of this section if we determine that a lower level is achievable by all engines or vehicles in that subclass.

(d) EPA may set the upper limit at a level above the level specified in paragraph (a) of this section if we determine that such level will not be achievable by all engines or vehicles in that subclass.

■ 48. Section 86.1105–87 is amended by revising paragraph (e) and removing paragraph (j).

The revision reads as follows:

§ 86.1105–87 Emission standards for which nonconformance penalties are available.

* * * * *

(e) The values of COC50, COC90, and MC50 in paragraphs (a) and (b) of this section are expressed in December 1984 dollars. The values of COC50, COC90, and MC50 in paragraphs (c) and (d) of this section are expressed in December 1989 dollars. The values of COC50, COC90, and MC50 in paragraph (f) of this section are expressed in December 1991 dollars. The values of COC50, COC90, and MC50 in paragraphs (g) and (h) of this section are expressed in December 1994 dollars. The values of COC50, COC90, and MC50 in paragraph (i) of this section are expressed in December 2001 dollars. These values shall be adjusted for inflation to dollars as of January of the calendar year preceding the model year in which the NCP is first available by using the change in the overall Consumer Price Index, and rounded to the nearest whole dollar in accordance with 40 CFR 1065.20.

* * * * *

■ 49. Section 86.1113–87 is amended by revising paragraphs (f) and (g)(3) introductory text to read as follows:

§ 86.1113–87 Calculation and payment of penalty.

* * * * *

(f) A manufacturer may request a hearing under 40 CFR part 1068, subpart G, as to whether the compliance level (including a compliance level in excess of the upper limit) was determined properly.

(g) * * *

(3) A manufacturer making payment under paragraph (g)(1) or (2) of this section shall submit the following information by each quarterly due date to the Designated Compliance Officer (*see* 40 CFR 1036.801). This information shall be submitted even if a manufacturer has no NCP production in a given quarter.

* * * * *

■ 50. Section 86.1115–87 is revised to read as follows:

§ 86.1115–87 Hearing procedures for nonconformance determinations and penalties.

The provisions of 40 CFR part 1068, subpart G, apply if a manufacturer requests a hearing regarding penalties under this subpart.

Subpart N—Exhaust Test Procedures for Heavy-Duty Engines

■ 51. Section 86.1362 is amended by revising paragraph (a) to read as follows:

§ 86.1362 Steady-state testing with a ramped-modal cycle.

* * * * *

(a) Measure emissions by testing the engine on a dynamometer with the following ramped-modal duty cycle to determine whether it meets the applicable steady-state emission standards:

RMC mode	Time in mode (seconds)	Engine speed [1 2]	Torque (percent) [2 3]	CO_2 weighting (percent)[4]
1a Steady-state	170	Warm Idle	0	6
1b Transition	20	Linear Transition	Linear Transition..	
2a Steady-state	173	A	100	9
2b Transition	20	Linear Transition	Linear Transition..	
3a Steady-state	219	B	50	10
3b Transition	20	B	Linear Transition..	
4a Steady-state	217	B	75	10
4b Transition	20	Linear Transition	Linear Transition..	
5a Steady-state	103	A	50	12
5b Transition	20	A	Linear Transition..	
6a Steady-state	100	A	75	12
6b Transition	20	A	Linear Transition..	
7a Steady-state	103	A	25	12
7b Transition	20	Linear Transition	Linear Transition..	
8a Steady-state	194	B	100	9
8b Transition	20	B	Linear Transition..	
9a Steady-state	218	B	25	9
9b Transition	20	Linear Transition	Linear Transition..	
10a Steady-state	171	C	100	2
10b Transition	20	C	Linear Transition..	
11a Steady-state	102	C	25	1
11b Transition	20	C	Linear Transition..	
12a Steady-state	100	C	75	1
12b Transition	20	C	Linear Transition..	
13a Steady-state	102	C	50	1
13b Transition	20	Linear Transition	Linear Transition..	
14 Steady-state	168	Warm Idle	0	6

[1] Speed terms are defined in 40 CFR part 1065.

[2] Advance from one mode to the next within a 20-second transition phase. During the transition phase, command a linear progression from the speed or torque setting of the current mode to the speed or torque setting of the next mode.

[3] The percent torque is relative to maximum torque at the commanded engine speed.

[4] Use the specified weighting factors to calculate composite emission results for CO_2 as specified in 40 CFR 1036.501.

* * * * * * *

■ 52. Section 86.1370 is amended by revising paragraphs (g) and (h) and adding paragraphs (i) and (j) to read as follows:

§ 86.1370 Not-To-Exceed test procedures.

* * * * *

(g) You may exclude emission data based on catalytic aftertreatment temperatures as follows:

(1) For an engine equipped with a catalytic NO_X aftertreatment system, exclude NO_X emission data that is collected when the exhaust temperature at any time during the NTE event is less than 250 °C.

(2) For an engine equipped with an oxidizing catalytic aftertreatment system, exclude NMHC and CO emission data that is collected if the exhaust temperature is less than 250 °C at any time during the NTE event.

(3) Using good engineering judgment, measure exhaust temperature within 30 cm downstream of the last applicable catalytic aftertreatment device. Where there are parallel paths, use good engineering judgment to measure the temperature within 30 cm downstream of the last applicable catalytic aftertreatment device in the path with the greatest exhaust flow.

(h) Any emission measurements corresponding to engine operating conditions that do not qualify as a valid NTE sampling event may be excluded from the determination of the vehicle-pass ratio specified in § 86.1912 for the specific pollutant.

(i) Start emission sampling at the beginning of each valid NTE sampling event, except as needed to allow for zeroing or conditioning the PEMS. For gaseous emissions, PEMS preparation must be complete for all analyzers before starting emission sampling.

(j) Emergency vehicle AECDs. If your engine family includes engines with one or more approved AECDs for emergency vehicle applications under paragraph (4) of the definition of ''defeat device'' in § 86.1803, the NTE emission limits do not apply when any of these AECDs are active.

Subpart S—General Compliance Provisions for Control of Air Pollution From New and In-Use Light-Duty Vehicles, Light-Duty Trucks, and Heavy-Duty Vehicles

§ 86.1801–12 [Amended]

■ 53. Section 86.1801–12 is amended by removing and reserving paragraph (a)(2)(ii).

■ 54. Section 86.1802–01 is revised to read as follows:

§ 86.1802–01 Section numbering; construction.

(a) Section numbering. The model year of initial applicability is indicated by the section number. The two digits following the hyphen designate the first model year for which a section is applicable. The section continues to apply to subsequent model years unless a later model year section is adopted. Example: Section 86.18xx–10 applies to model year 2010 and later vehicles. If a § 86.18xx–17 is promulgated, it would apply beginning with the 2017 model year; § 86.18xx–10 would apply only to model years 2010 through 2016, except as specified in § 86.18xx–17.

(b) A section reference without a model year suffix refers to the section applicable for the appropriate model year.

(c) If the regulation references a section that has been superseded or no longer exists, this should be understood as a reference to the same section for the appropriate model year. For example, if the regulation refers to § 86.1845–01, it should be taken as a reference to § 86.1845–04 or any later version of § 86.1845 that applies for the appropriate model year. However, this does not apply if the reference to a superseded section specifically states that the older provision applies instead of any updated provisions from the section in effect for the current model year; this occurs most often as part of the transition to new emission standards.

■ 55. Section 86.1803–01 is amended as follows:

■ a. By revising the definitions for ''Base level'', ''Base tire'', ''Base vehicle'', and ''Basic engine''.

■ b. By adding a definition for ''Cab-complete vehicle''.

■ c. By revising the definitions for ''Carbon-related exhaust emissions (CREE)'', ''Configuration'', paragraph (1) of ''Emergency vehicle'', ''Engine code'', ''Highway Fuel Economy Test Procedure (HFET)'', ''Mild hybrid electric vehicle'', ''Model type'', ''Production volume'', ''Strong hybrid electric vehicle'', ''Subconfiguration'', ''Transmission class'', and ''Transmission configuration''.

■ d. By adding a definitions for ''Transmission type''.

The revisions and additions read as follows:

§ 86.1803–01 Definitions.

* * * * *

Base level has the meaning given in 40 CFR 600.002.

Base tire has the meaning given in 40 CFR 600.002.

Base vehicle has the meaning given in 40 CFR 600.002.

Basic engine has the meaning given in 40 CFR 600.002.

* * * * *

Cab-complete vehicle means a heavy-duty vehicle that is first sold as an incomplete vehicle that substantially includes its cab. Vehicles known commercially as chassis-cabs, cab-chassis, box-deletes, bed-deletes, cut-away vans are considered cab-complete vehicles. For purposes of this definition, a cab includes a steering column and passenger compartment. Note that a vehicle lacking some components of the cab is a cab-complete vehicle if it substantially includes the cab.

* * * * *

Carbon-related exhaust emissions (CREE) has the meaning given in 40 CFR 600.002.

* * * * *

Configuration means one of the following:

(1) For LDV, LDT, and MDPV, *configuration* means a subclassification within a test group which is based on engine code, inertia weight class, transmission type and gear ratios, final drive ratio, and other parameters which may be designated by the Administrator.

(2) For HDV, *configuration* has the meaning given in § 86.1819–14(d)(12).

* * * * *

Emergency vehicle * * *

(1) For the greenhouse gas emission standards in §§ 86.1818 and 86.1819, *emergency vehicle* means a motor vehicle manufactured primarily for use as an ambulance or combination ambulance-hearse or for use by the United States Government or a State or local government for law enforcement.

* * * * *

Engine code means one of the following:

(1) For LDV, LDT, and MDPV, *engine code* means a unique combination within a test group of displacement, fuel injection (or carburetor) calibration, choke calibration, distributor calibration, auxiliary emission control devices, and other engine and emission control system components specified by the Administrator. For electric vehicles, engine code means a unique combination of manufacturer, electric traction motor, motor configuration, motor controller, and energy storage device.

(2) For HDV, *engine code* has the meaning given in § 86.1819–14(d)(12).

* * * * *

Highway Fuel Economy Test Procedure (HFET) has the meaning given in 40 CFR 600.002.

* * * * *

Mild hybrid electric vehicle means a hybrid electric vehicle that has start/stop capability and regenerative braking capability, where the recovered energy over the Federal Test Procedure is at least 15 percent but less than 65 percent of the total braking energy, as measured and calculated according to § 600.116–12(d).

Model type has the meaning given in 40 CFR 600.002.

* * * * *

Production volume has the meaning given in 40 CFR 600.002.

* * * * *

Strong hybrid electric vehicle means a hybrid electric vehicle that has start/stop capability and regenerative braking capability, where the recovered energy over the Federal Test Procedure is at least 65 percent of the total braking energy, as measured and calculated according to § 600.116–12(d).

Subconfiguration means one of the following:

(1) For LDV, LDT, and MDPV, *subconfiguration* has the meaning given in 40 CFR 600.002.

(2) For HDV, *subconfiguration* has the meaning given in § 86.1819–14(d)(12).

* * * * *

Transmission class has the meaning given in 40 CFR 600.002.

Transmission configuration has the meaning given in 40 CFR 600.002.

Transmission type means the basic type of the transmission (*e.g.,* automatic, manual, automated manual, semi-automatic, or continuously variable) and does not include the drive system of the vehicle (*e.g.,* front-wheel drive, rear-wheel drive, or four-wheel drive).

* * * * *

■ 56. Section 86.1805–17 is amended by revising paragraph (b) to read as follows:

§ 86.1805–17 Useful life.

* * * * *

(b) *Greenhouse gas pollutants.* The emission standards in § 86.1818 apply for a useful life of 10 years or 120,000 miles for LDV and LLDT and 11 years or 120,000 miles for HLDT and MDPV. For non-MDPV heavy-duty vehicles, the emission standards in § 86.1819 apply for a useful life of 11 years or 120,000 miles through model year 2020, and for a useful life of 15 years or 150,000 miles in model year 2021 and later. Manufacturers may certify based on the useful life as specified in paragraph (d) of this section if it is different than the useful life specified in this paragraph (b).

* * * * *

■ 57. Section 86.1811–17 is amended by revising paragraph (g) to read as follows:

§ 86.1811–17 Exhaust emission standards for light-duty vehicles, light-duty trucks and medium-duty passenger vehicles.

* * * * *

(g) *Cold temperature exhaust emission standards.* The standards in this paragraph (g) apply for certification and in-use vehicles tested over the test procedures specified in subpart C of this part. These standards apply only to gasoline-fueled vehicles. Multi-fuel, bi-fuel or dual-fuel vehicles must comply with requirements using gasoline only. Testing with other fuels such as a high-level ethanol-gasoline blend, or testing on diesel vehicles, is not required.

(1) *Cold temperature CO standards.* Cold temperature CO exhaust emission standards apply for testing at both low-altitude conditions and high-altitude conditions as follows:

(i) For LDV and LDT1, the standard is 10.0 g/mile CO.

(ii) For LDT2, LDT3 and LDT4, the standard is 12.5 grams per mile CO.

(2) *Cold temperature NMHC standards.* The following fleet average cold temperature NMHC standards apply as follows:

(i) The standards are shown in the following table:

TABLE 5 OF § 86.1811–17—FLEET AVERAGE COLD TEMPERATURE NMHC EXHAUST EMISSION STANDARDS

Vehicle weight category	Cold temperature NMHC sales-weighted fleet average standard (g/mile)
LDV and LLDT	0.3
HLDT	0.5

(ii) The manufacturer must calculate its fleet average cold temperature NMHC emission level(s) as described in § 86.1864–10(m).

(iii) The standards specified in this paragraph (g)(2) apply only for testing at low-altitude conditions. However, manufacturers must submit an engineering evaluation indicating that common calibration approaches are utilized at high altitudes. Any deviation from low altitude emission control practices must be included in the auxiliary emission control device (AECD) descriptions submitted at certification. Any AECD specific to high altitude must require engineering emission data for EPA evaluation to quantify any emission impact and validity of the AECD.

* * * * *

■ 58. Section 86.1816–18 is amended by revising paragraphs (a) introductory text, (b)(7)(i) introductory text, and (b)(9) to read as follows:

§ 86.1816–18 Emission standards for heavy-duty vehicles.

(a) *Applicability and general provisions.* This section describes exhaust emission standards that apply for model year 2018 and later complete heavy-duty vehicles. These standards are optional for incomplete heavy-duty vehicles and for heavy duty vehicles above 14,000 pounds GVWR as described in § 86.1801. Greenhouse gas emission standards are specified in § 86.1818 for MDPV and in § 86.1819 for other HDV. See § 86.1813 for evaporative and refueling emission standards. This section may apply to vehicles before model year 2018 as specified in paragraph (b)(11) of this section. Separate requirements apply for MDPV as specified in § 86.1811. See subpart A of this part for requirements that apply for incomplete heavy-duty vehicles and for heavy-duty engines certified independent of the chassis. The following general provisions apply:

* * * * *

(b) * * *

(7) * * *

(i) The fleet-average FTP emission standard for $NMOG+NO_X$ phases in over several years as described in this paragraph (b)(7)(i). You must identify FELs as described in paragraph (b)(4) of this section and calculate a fleet-average emission level to show that you meet the FTP emission standard for $NMOG+NO_X$ that applies for each model year. You may certify using transitional bin standards specified in Table 5 of this section through model year 2021; these vehicles are subject to the FTP emission standard for formaldehyde as described in § 86.1818–08. You may use the E0 test fuel specified in § 86.113 for gasoline-fueled vehicles certified to the transitional bins; the useful life period for these vehicles is 120,000 miles or 11 years. Fleet-average FTP emission standards decrease as shown in the following table:

* * * * *

(9) Except as specified in paragraph (b)(8) of this section, you may not use credits generated from vehicles certified under § 86.1816–08 for demonstrating compliance with the Tier 3 standards.

* * * * *

■ 59. Section 86.1818–12 is amended by revising paragraphs (a)(2), (c)(4), and (f)(4) to read as follows:

§ 86.1818–12 Greenhouse gas emission standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles.

(a) * * *

(2) The standards specified in this section apply for testing at both low-altitude conditions and high-altitude conditions. However, manufacturers must submit an engineering evaluation indicating that common calibration approaches are utilized at high altitude instead of performing testing for certification, consistent with § 86.1829. Any deviation from low altitude emission control practices must be included in the auxiliary emission control device (AECD) descriptions submitted at certification. Any AECD specific to high altitude requires engineering emission data for EPA evaluation to quantify any emission impact and determine the validity of the AECD.

* * * * *

(c) * * *

(4) *Emergency vehicles.* Emergency vehicles may be excluded from the emission standards described in this section. The manufacturer must notify the Administrator that they are making such an election in the model year reports required under § 600.512 of this chapter. Such vehicles should be excluded from both the calculation of the fleet average standard for a manufacturer under this paragraph (c) and from the calculation of the fleet average carbon-related exhaust emissions in § 600.510–12.

* * * * *

(f) * * *

(4) *CO_2-equivalent debits.* CO_2-equivalent debits for test groups using an alternative N_2O and/or CH_4 standard as determined under paragraph (f)(3) of this section shall be calculated according to the following equation and rounded to the nearest whole megagram:

$$\text{Debits} = [\text{GWP} \times (\text{Production}) \times (\text{AltStd} - \text{Std}) \times \text{VLM}] \div 1{,}000{,}000$$

Where:

Debits = CO_2-equivalent debits for N_2O or CH_4, in Megagrams, for a test group using an alternative N_2O or CH_4 standard, rounded to the nearest whole Megagram;

GWP = 25 if calculating CH_4 debits and 298 if calculating N_2O debits;

Production = The number of vehicles of that test group domestically produced plus those imported as defined in § 600.511 of this chapter;

AltStd = The alternative standard (N_2O or CH_4) selected by the manufacturer under paragraph (f)(3) of this section;

Std = The exhaust emission standard for N_2O or CH_4 specified in paragraph (f)(1) of this section; and

VLM = 195,264 for passenger automobiles and 225,865 for light trucks.

* * * * *

■ 60. Section 86.1819–14 is added to subpart S to read as follows:

§ 86.1819–14 Greenhouse gas emission standards for heavy-duty vehicles.

This section describes exhaust emission standards for CO_2, CH_4, and N_2O for heavy-duty vehicles. The standards of this section apply for model year 2014 and later vehicles that are chassis-certified with respect to criteria pollutants under this subpart S. Additional heavy-duty vehicles may be optionally subject to the standards of this section as allowed under paragraph (j) of this section. Any heavy-duty vehicles not subject to standards under this section are instead subject to greenhouse gas standards under 40 CFR part 1037, and engines installed in these vehicles are subject to standards under 40 CFR part 1036. If you are not the engine manufacturer, you must notify the engine manufacturer that its engines are subject to 40 CFR part 1036 if you intend to use their engines in vehicles that are not subject to standards under this section. Vehicles produced by small businesses may be excluded from the standards of this section as described in paragraph (k)(5) of this section.

(a) *Fleet-average CO_2 emission standards.* Fleet-average CO_2 emission standards apply for the full useful life for each manufacturer as follows:

(1) Calculate a work factor, *WF,* for each vehicle subconfiguration (or group of subconfigurations as allowed under paragraph (a)(4) of this section), rounded to the nearest pound, using the following equation:

$$WF = 0.75 \times (GVWR - Curb\ Weight + xwd) + 0.25 \times (GCWR - GVWR)$$

Where:

xwd = 500 pounds if the vehicle has four-wheel drive or all-wheel drive; *xwd* = 0 pounds for all other vehicles.

(2) Using the appropriate work factor, calculate a target value for each vehicle subconfiguration (or group of subconfigurations as allowed under paragraph (a)(4) of this section) you produce using one of the following equations, or the phase-in provisions in paragraph (k)(4) of this section, rounding to the nearest whole g/mile:

(i) For model year 2027 and later vehicles with spark-ignition engines:

$CO_2\ Target$ (g/mile) = $0.0369 \times WF + 284$

(ii) For model year 2027 and later vehicles with compression-ignition engines or with no engines (such as electric vehicles and fuel cell vehicles):

$CO_2\ Target$ (g/mile) = $0.0348 \times WF + 268$

(3) Calculate a production-weighted average of the target values and round it to the nearest whole g/mile. This is your fleet-average standard. All vehicles subject to the standards of this section form a single averaging set. Use the following equation to calculate your fleet-average standard from the target value for each vehicle subconfiguration ($Target_i$) and U.S.-directed production volume of each vehicle subconfiguration for the given model year ($Volume_i$):

$$\text{Fleet-Average Standard} = \frac{\sum\left[\text{Target}_i \times \text{Volume}_i\right]}{\sum\left[\text{Volume}_i\right]}$$

(4) You may group subconfigurations within a configuration together for purposes of calculating your fleet-average standard as follows:

(i) You may group together subconfigurations that have the same equivalent test weight (ETW), GVWR, and GCWR. Calculate your work factor and target value assuming a curb weight equal to two times ETW minus GVWR.

(ii) You may group together other subconfigurations if you use the lowest target value calculated for any of the subconfigurations.

(5) The standards specified in this section apply for testing at both low-altitude conditions and high-altitude conditions. However, manufacturers must submit an engineering evaluation indicating that common calibration approaches are utilized at high altitude instead of performing testing for certification, consistent with § 86.1829. Any deviation from low altitude emission control practices must be included in the auxiliary emission control device (AECD) descriptions submitted at certification. Any AECD specific to high altitude requires engineering emission data for EPA evaluation to quantify any emission impact and determine the validity of the AECD.

(b) *Production and in-use CO_2 standards.* Each vehicle you produce that is subject to the standards of this section has an ''in-use'' CO_2 standard that is calculated from your test result and that applies for selective enforcement audits and in-use testing. This in-use CO_2 standard for each vehicle is equal to the applicable deteriorated emission level multiplied by 1.10 and rounded to the nearest whole g/mile.

(c) *N_2O and CH_4 standards.* Except as allowed under this paragraph (c), all vehicles subject to the standards of this section must comply with an N_2O standard of 0.05 g/mile and a CH_4 standard of 0.05 g/mile when calculated according to the provisions of paragraph (d)(4) of this section. You may specify CH_4 and/or N_2O alternative standards using CO_2 emission credits instead of these otherwise applicable emission standards for one or more test groups. To do this, calculate the CH_4 and/or N_2O emission credits needed (negative credits) using the equation in this paragraph (c) based on the FEL(s) you specify for your vehicles during certification. You must adjust the calculated emissions by the global warming potential (*GWP*): *GWP* equals 25 for CH_4 and 298 for N_2O. This means you must use 25 Mg of positive CO_2 credits to offset 1 Mg of negative CH_4 credits and 298 Mg of positive CO_2 credits to offset 1 Mg of negative N_2O credits. Note that § 86.1818–12(f) does not apply for vehicles subject to the standards of this section. Calculate credits using the following equation:

$CO_2\ Credits\ Needed$ (Mg) = $[(FEL - Std) \times (U.S.\text{-}directed\ production\ volume) \times (Useful\ Life)] \times (GWP) \div 1{,}000{,}000$

(d) *Compliance provisions.* The following compliance provisions apply instead of other provisions described in this subpart S:

(1) The CO_2 standards of this section apply with respect to CO_2 emissions, not with respect to carbon-related exhaust emissions (CREE).

(2) The following general credit provisions apply:

(i) Credits you generate under this section may be used only to offset credit deficits under this section. You may bank credits for use in a future model year in which your average CO_2 level exceeds the standard. You may trade credits to another manufacturer according to § 86.1865–12(k)(8). Before you bank or trade credits, you must apply any available credits to offset a deficit if the deadline to offset that credit deficit has not yet passed.

(ii) Vehicles subject to the standards of this section are included in a single greenhouse gas averaging set separate from any averaging set otherwise included in this subpart S.

(iii) Banked CO_2 credits keep their full value for five model years after the year in which they were generated. Unused credits may not be used for more than five model years after the model year in which the credits are generated.

(3) Special credit and incentive provisions related to air conditioning in §§ 86.1867 and 86.1868 do not apply for vehicles subject to the standards of this section.

(4) Measure emissions using the procedures of subpart B of this part and 40 CFR part 1066. Determine separate emission results for the Federal Test Procedure (FTP) described in 40 CFR 1066.801(c)(1) and the Highway Fuel Economy Test (HFET) described in 40 CFR 1066.801(c)(3). Calculate composite

emission results from these two test cycles for demonstrating compliance with the CO_2, N_2O, and CH_4 standards based on a weighted average of the FTP (55%) and HFET (45%) emission results. Note that this differs from the way the criteria pollutant standards apply.

(5) Apply an additive deterioration factor of zero to measured CO_2 emissions unless good engineering judgment indicates that emissions are likely to deteriorate in use. Use good engineering judgment to develop separate deterioration factors for N_2O and CH_4.

(6) Credits are calculated using the useful life value (in miles) in place of ''vehicle lifetime miles'' as specified in § 86.1865. Calculate a total credit or debit balance in a model year by adding credits and debits from § 86.1865–12(k)(4), subtracting any CO_2-equivalent debits for N_2O or CH_4 calculated according to paragraph (c) of this section, and adding any of the following credits:

(i) Off-cycle technology credits according to paragraph (d)(13) of this section.

(ii) Early credits from vehicles certified under paragraph (k)(2) of this section.

(iii) Advanced technology credits according to paragraph (k)(7) of this section.

(7) [Reserved]

(8) The provisions of § 86.1818 do not apply.

(9) Calculate your fleet-average emission rate consistent with good engineering judgment and the provisions of § 86.1865. The following additional provisions apply:

(i) Unless we approve a lower number, you must test at least ten subconfigurations. If you produce more than 100 subconfigurations in a given model year, you must test at least ten percent of your subconfigurations. For purposes of this paragraph (d)(9)(i), count carryover tests, but do not include analytically derived CO_2 emission rates, data substitutions, or other untested allowances. We may approve a lower number of tests for manufacturers that have limited product offerings, or low sales volumes. Note that good engineering judgment and other provisions of this part may require you to test more subconfigurations than these minimum values.

(ii) The provisions of paragraph (g) of this section specify how you may use analytically derived CO_2 emission rates.

(iii) At least 90 percent of final production volume at the configuration level must be represented by test data (real, data substituted, or analytical).

(iv) Perform fleet-average CO_2 calculations as described in § 86.1865 and 40 CFR part 600, with the following exceptions:

(A) Use CO_2 emissions values for all test results, intermediate calculations, and fleet average calculations instead of the carbon-related exhaust emission (CREE) values specified in this subpart S and 40 CFR part 600.

(B) Perform intermediate CO_2 calculations for subconfigurations within each configuration using the subconfiguration and configuration definitions in paragraph (d)(12) of this section.

(C) Perform intermediate CO_2 calculations for configurations within each test group and transmission type (instead of configurations within each base level and base levels within each model type). Use the configuration definition in paragraph (d)(12)(i) of this section.

(D) Do not perform intermediate CO_2 calculations for each base level or for each model type. Base level and model type CO_2 calculations are not applicable to heavy-duty vehicles subject to standards in this section.

(E) Determine fleet average CO_2 emissions for heavy-duty vehicles subject to standards in this section as described in 40 CFR 600.510–12(j), except that the calculations must be performed on the basis of test group and transmission type (instead of the model-type basis specified in the light-duty vehicle regulations), and the calculations for dual fuel, multi-fuel, and flexible fuel vehicles must be consistent with the provisions of paragraph (d)(10)(i) of this section.

(10) For dual-fuel, multi-fuel, and flexible-fuel vehicles, perform exhaust testing on each fuel type (for example, gasoline and E85).

(i) For your fleet-average calculations, use either the conventional-fueled CO_2 emission rate or a weighted average of your emission results as specified in 40 CFR 600.510–12(k) for light-duty trucks.

(ii) If you certify to an alternate standard for N_2O or CH_4 emissions, you may not exceed the alternate standard when tested on either fuel.

(11) Test your vehicles with an equivalent test weight based on its Adjusted Loaded Vehicle Weight (ALVW). Determine equivalent test weight from the ALVW as specified in 40 CFR 1066.805; round ALVW values above 14,000 pounds to the nearest 500 pound increment.

(12) The following definitions apply for the purposes of this section:

(i) *Configuration* means a subclassification within a test group based on engine code, transmission type and gear ratios, final drive ratio, and other parameters we designate. Engine code means the combination of both ''engine code'' and ''basic engine'' as defined in 40 CFR 600.002.

(ii) *Subconfiguration* means a unique combination within a vehicle configuration (as defined in this paragraph (d)(12)) of equivalent test weight, road-load horsepower, and any other operational characteristics or parameters that we determine may significantly affect CO_2 emissions within a vehicle configuration. Note that for vehicles subject to standards of this section, equivalent test weight (ETW) is based on the ALVW of the vehicle as outlined in paragraph (d)(11) of this section.

(13) This paragraph (d)(13) applies for CO_2 reductions resulting from technologies that were not in common use before 2010 that are not reflected in the specified test procedures. These may be described as off-cycle or innovative technologies. We may allow you to generate emission credits consistent with the provisions of § 86.1869–12(c) and (d). You do not need to provide justification for not using the 5-cycle methodology.

(14) You must submit pre-model year reports before you submit your applications for certification for a given model year. Unless we specify otherwise, include the information specified for pre-model year reports in 49 CFR 535.8.

(15) You must submit a final report within 90 days after the end of the model year. Unless we specify otherwise, include applicable information identified in § 86.1865–12(l), 40 CFR 600.512, and 49 CFR 535.8(e). The final report must include at least the following information:

(i) Model year.

(ii) Applicable fleet-average CO_2 standard.

(iii) Calculated fleet-average CO_2 value and all the values required to calculate the CO_2 value.

(iv) Number of credits or debits incurred and all values required to calculate those values.

(v) Resulting balance of credits or debits.

(vi) N_2O emissions.

(vii) CH_4 emissions.

(viii) Total and percent leakage rates under paragraph (h) of this section.

(e) *Useful life.* The exhaust emission standards of this section apply for the full useful life, as described in § 86.1805.

(f) [Reserved]

(g) *Analytically derived CO_2 emission rates (ADCs).* This paragraph (g) describes an allowance to use estimated (*i.e.,* analytically derived) CO_2 emission rates based on baseline test data instead of measured emission rates for calculating fleet-average emissions. Note that these ADCs are similar to ADFEs used for light-duty vehicles. Note also that F terms used in this paragraph (g) represent coefficients from the following road load equation:

$$Force = F_0 + F_1 \cdot (velocity) + F_2 \cdot (velocity)^2$$

(1) Except as specified in paragraph (g)(2) of this section, use the following equation to calculate the ADC of a new vehicle from road load force coefficients ($F0$, $F1$, $F2$), axle ratio, and test weight:

$$ADC = CO_{2base} + 2.18 \cdot \Delta F0 + 37.4 \cdot \Delta F1 + 2257 \cdot \Delta F2 + 189 \cdot \Delta AR + 0.0222 \cdot \Delta ETW$$

Where:

ADC = Analytically derived combined city/highway CO_2 emission rate (g/mile) for a new vehicle.

CO_{2base} = Combined city/highway CO_2 emission rate (g/mile) of a baseline vehicle.

$\Delta F0$ = $F0$ of the new vehicle—$F0$ of the baseline vehicle.

$\Delta F1$ = $F1$ of the new vehicle—$F1$ of the baseline vehicle.

$\Delta F2$ = $F2$ of the new vehicle—$F2$ of the baseline vehicle.

ΔAR = Axle ratio of the new vehicle—axle ratio of the baseline vehicle.

ΔETW = ETW of the new vehicle—ETW of the baseline vehicle.

(2) The purpose of this section is to accurately estimate CO_2 emission rates.

(i) You must apply the provisions of this section consistent with good engineering judgment. For example, do not use the equation in paragraph (g)(1) of this section where good engineering judgment indicates that it will not accurately estimate emissions. You may ask us to approve alternate equations that allow you to estimate emissions more accurately.

(ii) The analytically derived CO_2 equation in paragraph (g)(1) of this section may be periodically updated through publication of an EPA guidance document to more accurately characterize CO_2 emission levels for example, changes may be appropriate based on new test data, future technology changes, or to changes in future CO_2 emission levels. Any EPA guidance document will determine the model year that the updated equation takes effect. We will issue guidance no later than eight months before the effective model year. For example, model year 2014 may start January 2, 2013, so guidance for model year 2014 would be issued by May 1, 2012.

(3) You may select baseline test data without our advance approval if they meet all the following criteria:

(i) Vehicles considered for the baseline test must comply with all applicable emission standards in the model year associated with the ADC.

(ii) You must include in the pool of tests considered for baseline selection all official tests of the same or equivalent basic engine, transmission class, engine code, transmission code, engine horsepower, dynamometer drive wheels, and compression ratio as the ADC subconfiguration. Do not include tests in which emissions exceed any applicable standard.

(iii) Where necessary to minimize the CO_2 adjustment, you may supplement the pool with tests associated with worst-case engine or transmission codes and carryover or carry-across engine families. If you do, all the data that qualify for inclusion using the elected worst-case substitution (or carryover or carry-across) must be included in the pool as supplemental data (*i.e.,* individual test vehicles may not be selected for inclusion). You must also include the supplemental data in all subsequent pools, where applicable.

(iv) Tests previously used during the subject model year as baseline tests in ten other ADC subconfigurations must be eliminated from the pool.

(v) Select the tested subconfiguration with the smallest absolute difference between the ADC and the test CO_2 emission rate for combined emissions. Use this as the baseline test for the target ADC subconfiguration.

(4) You may ask us to allow you to use baseline test data not fully meeting the provisions of paragraph (g)(3) of this section.

(5) Calculate the ADC rounded to the nearest whole g/mile. Except with our advance approval, the downward adjustment of ADC from the baseline is limited to ADC values 20 percent below the baseline emission rate. The upward adjustment is not limited.

(6) You may not submit an ADC if an actual test has been run on the target subconfiguration during the certification process or on a development vehicle that is eligible to be declared as an emission-data vehicle.

(7) No more than 40 percent of the subconfigurations tested in your final CO_2 submission may be represented by ADCs.

(8) Keep the following records for at least five years, and show them to us if we ask to see them:

(i) The pool of tests.

(ii) The vehicle description and tests chosen as the baseline and the basis for the selection.

(iii) The target ADC subconfiguration.

(iv) The calculated emission rates.

(9) We may perform or order a confirmatory test of any subconfiguration covered by an ADC.

(10) Where we determine that you did not fully comply with the provisions of this paragraph (g), we may require that you comply based on actual test data and that you recalculate your fleet-average emission rate.

(h) *Air conditioning leakage.* Loss of refrigerant from your air conditioning systems may not exceed a total leakage rate of 11.0 grams per year or a percent leakage rate of 1.50 percent per year, whichever is greater. Calculate the total leakage rate in g/year as specified in § 86.1867–12(a). Calculate the percent leakage rate as: [total leakage rate (g/yr)] ÷ [total refrigerant capacity (g)] × 100. Round your percent leakage rate to the nearest one-hundredth of a percent.

(1) For purpose of this requirement, ‘‘refrigerant capacity’’ is the total mass of refrigerant recommended by the vehicle manufacturer as representing a full charge. Where full charge is specified as a pressure, use good engineering judgment to convert the pressure and system volume to a mass.

(2) If your system uses a refrigerant other than HFC–134a that is listed as an acceptable substitute refrigerant for heavy-duty vehicles under 40 CFR part 82, subpart G, and the substitute refrigerant is identified in § 86.1867–12(e), your system is deemed to meet the leakage standard in this paragraph (h), consistent with good engineering judgment, and the reporting requirement of § 86.1844–01(d)(7))(iv) does not apply. If your system uses any other refrigerant that is listed as an acceptable substitute refrigerant for heavy-duty vehicles under 40 CFR part 82, subpart G, contact us for procedures for calculating the leakage rate in a way that appropriately accounts for the refrigerant's properties.

(i) [Reserved]

(j) *Optional GHG certification under this subpart.* You may certify certain complete or cab-complete vehicles to the GHG standards of this section. All vehicles optionally certified under this paragraph (j) are deemed to be subject to the GHG standards of this section. Note that for vehicles above 14,000 pounds GVWR and at or below 26,000 pounds GVWR, GHG certification under this paragraph (j) does not affect how you may or may not certify with respect to criteria pollutants.

(1) For GHG compliance, you may certify any complete or cab-complete spark-ignition vehicles above 14,000 pounds GVWR and at or below 26,000 pounds GVWR to the GHG standards of this section even though this section otherwise specifies that you may certify

vehicles to the GHG standards of this section only if they are chassis-certified for criteria pollutants.

(2) You may apply the provisions of this section to cab-complete vehicles based on a complete sister vehicle. In unusual circumstances, you may ask us to apply these provisions to Class 2b or Class 3 incomplete vehicles that do not meet the definition of cab-complete.

(i) Except as specified in paragraph (j)(3) of this section, for purposes of this section, a complete sister vehicle is a complete vehicle of the same vehicle configuration as the cab-complete vehicle. You may not apply the provisions of this paragraph (j) to any vehicle configuration that has a four-wheel rear axle if the complete sister vehicle has a two-wheel rear axle.

(ii) Calculate the target value for fleet-average CO_2 emissions under paragraph (a) or (k)(4) of this section based on the work factor value that applies for the complete sister vehicle.

(iii) Test these cab-complete vehicles using the same equivalent test weight and other dynamometer settings that apply for the complete vehicle from which you used the work factor value (the complete sister vehicle). For GHG certification, you may submit the test data from that complete sister vehicle instead of performing the test on the cab-complete vehicle.

(iv) You are not required to produce the complete sister vehicle for sale to use the provisions of this paragraph (j)(2). This means the complete sister vehicle may be a carryover vehicle from a prior model year or a vehicle created solely for the purpose of testing.

(3) For GHG purposes, if a cab-complete vehicle is not of the same vehicle configuration as a complete sister vehicle due only to certain factors unrelated to coastdown performance, you may use the road-load coefficients from the complete sister vehicle for certification testing of the cab-complete vehicle, but you may not use emission data from the complete sister vehicle for certifying the cab-complete vehicle.

(k) *Interim provisions.* The following provisions apply instead of other provisions in this subpart:

(1) *Incentives for early introduction.* Manufacturers may voluntarily certify in model year 2013 (or earlier model years for electric vehicles) to the greenhouse gas standards that apply starting in model year 2014 as specified in 40 CFR 1037.150(a).

(2) *Early credits.* To generate early credits under this paragraph (k)(2) for any vehicles other than electric vehicles, you must certify your entire U.S.-directed fleet to these standards. If you calculate a separate fleet average for advanced-technology vehicles under paragraph (k)(7) of this section, you must certify your entire U.S.-directed production volume of both advanced and conventional vehicles within the fleet. If some test groups are certified after the start of the model year, you may generate credits only for production that occurs after all test groups are certified. For example, if you produce three test groups in an averaging set and you receive your certificates for those test groups on January 4, 2013, March 15, 2013, and April 24, 2013, you may not generate credits for model year 2013 for vehicles from any of the test groups produced before April 24, 2013. Calculate credits relative to the standard that would apply in model year 2014 using the applicable equations in this subpart and your model year 2013 U.S.-directed production volumes. These credits may be used to show compliance with the standards of this subpart for 2014 and later model years. We recommend that you notify us of your intent to use this provision before submitting your applications.

(3) *Compliance date.* Compliance with the standards of this section was optional before January 1, 2014 as specified in 40 CFR 1037.150(g).

(4) *Phase-in provisions.* Each manufacturer must choose one of the options specified in paragraphs (k)(4)(i) and (ii) of this section for phasing in the Phase 1 standards. Manufacturers must follow the schedule described in paragraph (k)(4)(iii) of this section for phasing in the Phase 2 standards.

(i) *Phase 1—Option 1.* You may implement the Phase 1 standards by applying CO_2 target values as specified in the following table for model year 2014 through 2020 vehicles:

TABLE 1 OF § 86.1819–14

Model year and engine cycle	Alternate CO_2 target (g/mile)
2014 Spark-Ignition	0.0482 × (WF) + 371
2015 Spark-Ignition	0.0479 × (WF) + 369
2016 Spark-Ignition	0.0469 × (WF) + 362
2017 Spark-Ignition	0.0460 × (WF) + 354
2018–2020 Spark-Ignition	0.0440 × (WF) + 339
2014 Compression-Ignition	0.0478 × (WF) + 368
2015 Compression-Ignition	0.0474 × (WF) + 366
2016 Compression-Ignition	0.0460 × (WF) + 354
2017 Compression-Ignition	0.0445 × (WF) + 343
2018–2020 Compression-Ignition.	0.0416 × (WF) + 320

(ii) *Phase 1—Option 2.* You may implement the Phase 1 standards by applying CO_2 target values specified in the following table for model year 2014 through 2020 vehicles:

TABLE 2 OF § 86.1819–14

Model year and engine cycle	Alternate CO_2 target (g/mile)
2014 Spark-Ignition	0.0482 × (WF) + 371
2015 Spark-Ignition	0.0479 × (WF) + 369
2016–2018 Spark-Ignition	0.0456 × (WF) + 352
2019–2020 Spark-Ignition	0.0440 × (WF) + 339
2014 Compression-Ignition	0.0478 × (WF) + 368
2015 Compression-Ignition	0.0474 × (WF) + 366
2016–2018 Compression-Ignition.	0.0440 × (WF) + 339
2019–2020 Compression-Ignition.	0.0416 × (WF) + 320

(iii) *Phase 2.* Apply Phase 2 CO_2 target values as specified in the following table for model year 2021 through 2026 vehicles:

TABLE 3 OF § 86.1819–14

Model year and engine cycle	Alternate CO_2 target (g/mile)
2021 Spark-Ignition	0.0429 × (WF) + 331
2022 Spark-Ignition	0.0418 × (WF) + 322
2023 Spark-Ignition	0.0408 × (WF) + 314
2024 Spark-Ignition	0.0398 × (WF) + 306
2025 Spark-Ignition	0.0388 × (WF) + 299
2026 Spark-Ignition	0.0378 × (WF) + 291
2021 Compression-Ignition	0.0406 × (WF) + 312
2022 Compression-Ignition	0.0395 × (WF) + 304
2023 Compression-Ignition	0.0386 × (WF) + 297
2024 Compression-Ignition	0.0376 × (WF) + 289
2025 Compression-Ignition	0.0367 × (WF) + 282
2026 Compression-Ignition	0.0357 × (WF) + 275

(5) *Provisions for small manufacturers.* Standards apply on a delayed schedule for manufacturers meeting the small business criteria specified in 13 CFR 121.201. Apply the small business criteria for NAICS code 336111 for vehicle manufacturers and 811198 for companies performing fuel conversions with vehicles manufactured by a different company. Qualifying manufacturers are not subject to the greenhouse gas standards of this section for vehicles built before January 1, 2019, as specified in 40 CFR 1037.150(c). The employee and revenue limits apply to the total number employees and total revenue together for affiliated companies. In addition, manufacturers producing vehicles that run on any fuel other than gasoline, E85, or diesel fuel may delay complying with every new standard under this part by one model year.

(6) *Alternate N_2O standards.* Manufacturers may show compliance with the N_2O standards using an engineering analysis. This allowance also applies for model year 2015 and later test groups or emission families carried over from model 2014 consistent with the provisions of § 86.1839. You may not certify to an N_2O FEL different than the standard without measuring N_2O emissions.

(7) *Advanced technology credits.* Credits generated from hybrid vehicles

with regenerative braking or from vehicles with other advanced technologies may be used to show compliance with any standards of this part or 40 CFR part 1036, subject to the service class restrictions in 40 CFR 1037.740. You may multiply these credits by 1.50. Include these vehicles in a separate fleet-average calculation (and exclude them from your conventional fleet-average calculation). You must first apply these advanced technology vehicle credits to any deficits for other vehicles in the averaging set before applying them to other averaging sets. Credits you generate under this paragraph (k)(7) may be used to demonstrate compliance with the CO_2 emission standards in 40 CFR part 1036 and part 1037. Similarly, you may use advanced-technology credits generated under 40 CFR 1036.615 or 1037.615 to demonstrate compliance with the CO_2 standards in this section. You may generate advanced technology credits under this paragraph (k)(7) only with Phase 1 vehicles.

(8) *Loose engine sales.* This paragraph (k)(8) applies for model year 2020 and earlier spark-ignition engines identical to engines used in vehicles certified to the standards of this section, where you sell such engines as loose engines or as engines installed in incomplete vehicles that are not cab-complete vehicles. For purposes of this paragraph (k)(8), engines would not be considered to be identical if they used different engine hardware. You may include such engines in a test group certified to the standards of this section, subject to the following provisions:

(i) Engines certified under this paragraph (k)(8) are deemed to be certified to the standards of 40 CFR 1036.108 as specified in 40 CFR 1036.150(j).

(ii) The U.S.-directed production volume of engines you sell as loose engines or installed in incomplete heavy-duty vehicles that are not cab-complete vehicles in any given model year may not exceed ten percent of the total U.S-directed production volume of engines of that design that you produce for heavy-duty applications for that model year, including engines you produce for complete vehicles, cab-complete vehicles, and other incomplete vehicles. The total number of engines you may certify under this paragraph (k)(8), of all engine designs, may not exceed 15,000 in any model year. Engines produced in excess of either of these limits are not covered by your certificate. For example, if you produce 80,000 complete model year 2017 Class 2b pickup trucks with a certain engine and 10,000 incomplete model year 2017 Class 3 vehicles with that same engine, and you do not apply the provisions of this paragraph (k)(8) to any other engine designs, you may produce up to 10,000 engines of that design for sale as loose engines under this paragraph (k)(8). If you produced 11,000 engines of that design for sale as loose engines, the last 1,000 of them that you produced in that model year 2017 would be considered uncertified.

(iii) This paragraph (k)(8) does not apply for engines certified to the standards of 40 CFR 1036.108.

(iv) Label the engines as specified in 40 CFR 1036.135 including the following compliance statement: ''THIS ENGINE WAS CERTIFIED TO THE ALTERNATE GREENHOUSE GAS EMISSION STANDARDS OF 40 CFR 1036.150(j).'' List the test group name instead of an engine family name.

(v) Vehicles using engines certified under this paragraph (k)(8) are subject to the emission standards of 40 CFR 1037.105.

(vi) For certification purposes, your engines are deemed to have a CO_2 target value and test result equal to the CO_2 target value and test result for the complete vehicle in the applicable test group with the highest equivalent test weight, except as specified in paragraph (k)(8)(vi)(B) of this section. Use these values to calculate your target value, fleet-average emission rate, and in-use emission standard. Where there are multiple complete vehicles with the same highest equivalent test weight, select the CO_2 target value and test result as follows:

(A) If one or more of the CO_2 test results exceed the applicable target value, use the CO_2 target value and test result of the vehicle that exceeds its target value by the greatest amount.

(B) If none of the CO_2 test results exceed the applicable target value, select the highest target value and set the test result equal to it. This means that you may not generate emission credits from vehicles certified under this paragraph (k)(8).

(vii) State in your applications for certification that your test group and engine family will include engines certified under this paragraph (k)(8). This applies for your greenhouse gas vehicle test group and your criteria pollutant engine family. List in each application the name of the corresponding test group/engine family.

(9) *Credit adjustment for useful life.* For credits that you calculate based on a useful life of 120,000 miles, multiply any banked credits that you carry forward for use in model year 2021 and later by 1.25.

(10) *CO_2 rounding.* For model year 2014 and earlier vehicles, you may round measured and calculated CO_2 emission levels to the nearest 0.1 g/mile, instead of the nearest whole g/mile as specified in paragraphs (a), (b), and (g) of this section.

■ 61. Section 86.1823–08 is amended by revising the definition of ''R'' in paragraph (d)(3) to read as follows:

§ 86.1823–08 Durability demonstration procedures for exhaust emissions.

* * * * *

(d) * * *

(3) * * *

R = Catalyst thermal reactivity coefficient. You may use a default value of 17,500 for the SBC.

* * * * *

■ 62. Section 86.1838–01 is amended by revising paragraph (b)(1)(i)(B), adding paragraph (b)(1)(i)(C), and revising paragraph (d)(3)(iii) introductory text to read as follows:

§ 86.1838–01 Small-volume manufacturer certification procedures.

* * * * *

(b) * * *

(1) * * *

(i) * * *

(B) No small-volume sales threshold applies for the heavy-duty greenhouse gas standards; alternative small-volume criteria apply as described in § 86.1819–14(k)(4).

(C) 15,000 units for all other requirements. See § 86.1845 for separate provisions that apply for in-use testing.

* * * * *

(d) * * *

(3) * * *

(iii) Notwithstanding the requirements of paragraph (d)(3)(ii) of this section, an applicant may satisfy the requirements of this paragraph (d)(3) if the requirements of this paragraph (d)(3) are completed by an auditor who is an employee of the applicant, provided that such employee:

* * * * *

■ 63. Section 86.1844–01 is amended by adding paragraph (d)(7)(iv) to read as follows:

§ 86.1844–01 Information requirements: Application for certification and submittal of information upon request.

* * * * *

(d) * * *

(7) * * *

(iv) For heavy-duty vehicles subject to air conditioning standards under § 86.1819, include the refrigerant leakage rates (leak scores), describe the type of refrigerant, and identify the refrigerant capacity of the air conditioning systems. If another company will install the air conditioning system, also identify the corporate name of the final installer.

* * * * *

■ 64. Section 86.1846–01 is amended by revising paragraph (b)(1)(i) to read as follows:

§ 86.1846–01 Manufacturer in-use confirmatory testing requirements.

* * * * *

(b) * * *

(1) * * *

(i) Additional testing is not required under this paragraph (b)(1) based on evaporative/refueling testing or based on low-mileage Supplemental FTP testing conducted under § 86.1845–04(b)(5)(i). Testing conducted at high altitude under the requirements of § 86.1845–04(c) will be included in determining if a test group meets the criteria triggering the testing required under this section.

* * * * *

■ 65. Section 86.1848–10 is amended by revising paragraph (c)(9) to read as follows:

§ 86.1848–10 Compliance with emission standards for the purpose of certification.

* * * * *

(c) * * *

(9) For 2012 and later model year LDVs, LDTs, and MDPVs, all certificates of conformity issued are conditional upon compliance with all provisions of §§ 86.1818 and 86.1865 both during and after model year production. Similarly, for 2014 and later model year HDV, and other HDV subject to standards under § 86.1819, all certificates of conformity issued are conditional upon compliance with all provisions of §§ 86.1819 and 86.1865 both during and after model year production. The manufacturer bears the burden of establishing to the satisfaction of the Administrator that the terms and conditions upon which the certificate(s) was (were) issued were satisfied. For recall and warranty purposes, vehicles not covered by a certificate of conformity will continue to be held to the standards stated or referenced in the certificate that otherwise would have applied to the vehicles.

(i) Failure to meet the fleet average CO_2 requirements will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of the fleet average CO_2 standard will not be covered by the certificate(s). The vehicles sold in violation will be determined according to § 86.1865–12(k)(8).

(ii) Failure to comply fully with the prohibition against selling credits that are not generated or that are not available, as specified in § 86.1865–12, will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of this prohibition will not be covered by the certificate(s).

(iii) For manufacturers using the conditional exemption under § 86.1801–12(k), failure to fully comply with the fleet production thresholds that determine eligibility for the exemption will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of the stated sales and/or production thresholds will not be covered by the certificate(s).

(iv) For manufacturers that are determined to be operationally independent under § 86.1838–01(d), failure to report a material change in their status within 60 days as required by § 86.1838–01(d)(2) will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of the operationally independent criteria will not be covered by the certificate(s).

(v) For manufacturers subject to an alternative fleet average greenhouse gas emission standard approved under § 86.1818–12(g), failure to comply with the annual sales thresholds that are required to maintain use of those standards, including the thresholds required for new entrants into the U.S. market, will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of stated sales and/or production thresholds will not be covered by the certificate(s).

* * * * *

■ 66. Section 86.1853–01 is revised to read as follows:

§ 86.1853–01 Certification hearings.

If a manufacturer's request for a hearing is approved, EPA will follow the hearing procedures specified in 40 CFR part 1068, subpart G.

■ 67. Section 86.1854–12 is amended by adding paragraph (b)(5) to read as follows:

§ 86.1854–12 Prohibited acts.

* * * * *

(b) * * *

(5) Certified motor vehicles and motor vehicle engines and their emission control devices must remain in their certified configuration even if they are used solely for competition or if they become nonroad vehicles or engines; anyone modifying a certified motor vehicle or motor vehicle engine for any reason is subject to the tampering and defeat device prohibitions of paragraph (a)(3) of this section and 42 U.S.C. 7522(a)(3).

■ 68. Section 86.1862–04 is amended by revising paragraph (d) to read as follows:

§ 86.1862–04 Maintenance of records and submittal of information relevant to compliance with fleet-average standards.

* * * * *

(d) *Notice of opportunity for hearing.* Any voiding of the certificate under paragraph (a)(6) of this section will be made only after EPA has offered the manufacturer concerned an opportunity for a hearing conducted in accordance with 40 CFR part 1068, subpart G and, if a manufacturer requests such a hearing, will be made only after an initial decision by the Presiding Officer.

■ 69. Section 86.1865–12 is revised to read as follows:

§ 86.1865–12 How to comply with the fleet average CO_2 standards.

(a) *Applicability.* (1) Unless otherwise exempted under the provisions of paragraph (d) of this section, CO_2 fleet average exhaust emission standards of this subpart apply to:

(i) 2012 and later model year passenger automobiles and light trucks.

(ii) Heavy-duty vehicles subject to standards under § 86.1819.

(iii) Vehicles imported by ICIs as defined in 40 CFR 85.1502.

(2) The terms ''passenger automobile'' and ''light truck'' as used in this section have the meanings given in § 86.1818–12.

(b) *Useful life requirements.* Full useful life requirements for CO_2 standards are defined in §§ 86.1818 and 86.1819. There is not an intermediate useful life standard for CO_2 emissions.

(c) *Altitude.* Greenhouse gas emission standards apply for testing at both low-altitude conditions and at high-altitude conditions, as described in §§ 86.1818 and 86.1819.

(d) *Small volume manufacturer certification procedures.* (1) *Passenger automobiles and light trucks.* Certification procedures for small volume manufacturers are provided in § 86.1838. Small businesses meeting certain criteria may be exempted from the greenhouse gas emission standards in § 86.1818 according to the provisions of § 86.1801–12(j) or (k).

(2) *Heavy-duty vehicles.* HDV manufacturers that qualify as small businesses are not subject to the Phase 1 greenhouse gas standards of this subpart as specified in § 86.1819–14(k)(5).

(e) *CO_2 fleet average exhaust emission standards.* The fleet average standards referred to in this section are the corporate fleet average CO_2 standards for passenger automobiles and light trucks set forth in § 86.1818–12(c) and (e), and for HDV in § 86.1819. Each manufacturer must comply with the applicable CO_2 fleet average standard on a production-weighted average basis, for each separate averaging set, at the end of each model year, using the procedure described in paragraph (j) of this section. The fleet average CO_2 standards applicable in a given model year are calculated separately for passenger automobiles and light trucks for each manufacturer and each model year according to the provisions in § 86.1818. Calculate the HDV fleet average CO_2 standard in a given model year as described in § 86.1819–14(a).

(f) *In-use CO_2 standards.* In-use CO_2 exhaust emission standards are provided in § 86.1818–12(d) for passenger automobiles and light trucks and in § 86.1819–14(b) for HDV.

(g) *Durability procedures and method of determining deterioration factors (DFs).* Deterioration factors for CO_2 exhaust emission standards are provided in § 86.1823–08(m) for passenger automobiles and light trucks and in § 86.1819–14(d)(5) for HDV.

(h) *Vehicle test procedures.* (1) The test procedures for demonstrating compliance with CO_2 exhaust emission standards are described at § 86.101 and 40 CFR part 600, subpart B.

(2) Testing to determine compliance with CO_2 exhaust emission standards must be on a loaded vehicle weight (LVW) basis for passenger automobiles and light trucks (including MDPV), and on an adjusted loaded vehicle weight (ALVW) basis for non-MDPV heavy-duty vehicles.

(3) Testing for the purpose of providing certification data is required only at low-altitude conditions. If hardware and software emission control strategies used during low-altitude condition testing are not used similarly across all altitudes for in-use operation, the manufacturer must include a statement in the application for certification, in accordance with § 86.1844–01(d)(11), stating what the different strategies are and why they are used.

(i) *Calculating fleet average carbon-related exhaust emissions for passenger automobiles and light trucks.* (1) Manufacturers must compute separate production-weighted fleet average carbon-related exhaust emissions at the end of the model year for passenger automobiles and light trucks, using actual production, where production means vehicles produced and delivered for sale, and certifying model types to standards as defined in § 86.1818–12. The model type carbon-related exhaust emission results determined according to 40 CFR part 600, subpart F (in units of grams per mile rounded to the nearest whole number) become the certification standard for each model type.

(2) Manufacturers must separately calculate production-weighted fleet average carbon-related exhaust emissions levels for the following averaging sets according to the provisions of 40 CFR part 600, subpart F:

(i) Passenger automobiles subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(2);

(ii) Light trucks subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(3);

(iii) Passenger automobiles subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e), if applicable; and

(iv) Light trucks subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e), if applicable.

(j) *Certification compliance and enforcement requirements for CO_2 exhaust emission standards.* (1) Compliance and enforcement requirements are provided in this section and § 86.1848–10(c)(9).

(2) The certificate issued for each test group requires all model types within that test group to meet the in-use emission standards to which each model type is certified. The in-use standards for passenger automobiles and light duty trucks (including MDPV) are described in § 86.1818–12(d). The in-use standards for non-MDPV heavy-duty vehicles are described in § 86.1819–14(b).

(3) Each manufacturer must comply with the applicable CO_2 fleet average standard on a production-weighted average basis, at the end of each model year. Use the procedure described in paragraph (i) of this section for passenger automobiles and light trucks (including MDPV). Use the procedure described in § 86.1819(d)(9)(iv) for non-MDPV heavy-duty vehicles.

(4) Each manufacturer must comply on an annual basis with the fleet average standards as follows:

(i) Manufacturers must report in their annual reports to the Agency that they met the relevant corporate average standard by showing that the applicable production-weighted average CO_2 emission levels are at or below the applicable fleet average standards; or

(ii) If the production-weighted average is above the applicable fleet average standard, manufacturers must obtain and apply sufficient CO_2 credits as authorized under paragraph (k)(8) of this section. A manufacturer must show that they have offset any exceedance of the corporate average standard via the use of credits. Manufacturers must also include their credit balances or deficits in their annual report to the Agency.

(iii) If a manufacturer fails to meet the corporate average CO_2 standard for four consecutive years, the vehicles causing the corporate average exceedance will be considered not covered by the certificate of conformity (*see* paragraph (k)(8) of this section). A manufacturer will be subject to penalties on an individual-vehicle basis for sale of vehicles not covered by a certificate.

(iv) EPA will review each manufacturer's production to designate the vehicles that caused the exceedance of the corporate average standard. EPA will designate as nonconforming those vehicles in test groups with the highest certification emission values first, continuing until reaching a number of vehicles equal to the calculated number of noncomplying vehicles as determined in paragraph (k)(8) of this section. In a group where only a portion of vehicles would be deemed nonconforming, EPA will determine the actual nonconforming vehicles by counting backwards from the last vehicle produced in that test group. Manufacturers will be liable for penalties for each vehicle sold that is not covered by a certificate.

(k) *Requirements for the CO_2 averaging, banking and trading (ABT) program.* (1) A manufacturer whose CO_2 fleet average emissions exceed the applicable standard must complete the calculation in paragraph (k)(4) of this section to determine the size of its CO_2 deficit. A manufacturer whose CO_2 fleet average emissions are less than the applicable standard may complete the calculation in paragraph (k)(4) of this section to generate CO_2 credits. In either case, the number of credits or debits must be rounded to the nearest whole number.

(2) There are no property rights associated with CO_2 credits generated under this subpart. Credits are a limited authorization to emit the designated amount of emissions. Nothing in this part or any other provision of law should be construed to limit EPA's authority to terminate or limit this authorization through a rulemaking.

(3) Each manufacturer must comply with the reporting and recordkeeping requirements of paragraph (l) of this section for CO_2 credits, including early credits. The averaging, banking and trading program is enforceable through

the certificate of conformity that allows the manufacturer to introduce any regulated vehicles into U.S. commerce.

(4) Credits are earned on the last day of the model year. Manufacturers must calculate, for a given model year and separately for passenger automobiles, light trucks, and heavy-duty vehicles, the number of credits or debits it has generated according to the following equation rounded to the nearest megagram:

CO_2 *Credits or Debits* (Mg) = [(*CO_2 Standard* − *Manufacturer's Production-Weighted Fleet Average CO_2 Emissions*) × (*Total Number of Vehicles Produced*) × (*Mileage*)] ÷ 1,000,000

Where:

CO_2 Standard = the applicable standard for the model year as determined by § 86.1818 or § 86.1819;

Manufacturer's Production-Weighted Fleet Average CO_2 Emissions = average calculated according to paragraph (i) of this section;

Total Number of Vehicles Produced = the number of vehicles domestically produced plus those imported as defined in § 600.511–08 of this chapter; and

Mileage = useful life value (in miles) for HDV, and vehicle lifetime miles of 195,264 for passenger automobiles and 225,865 for light trucks.

(5) Determine total HDV debits and credits for a model year as described in § 86.1819–14(d)(6). Determine total passenger car and light truck debits and credits for a model year as described in this paragraph (k)(5). Total credits or debits generated in a model year, maintained and reported separately for passenger automobiles and light trucks, shall be the sum of the credits or debits calculated in paragraph (k)(4) of this section and any of the following credits, if applicable, minus any CO_2-equivalent debits for N_2O and/or CH_4 calculated according to the provisions of § 86.1818–12(f)(4):

(i) Air conditioning leakage credits earned according to the provisions of § 86.1867–12(b).

(ii) Air conditioning efficiency credits earned according to the provisions of § 86.1868–12(c).

(iii) Off-cycle technology credits earned according to the provisions of § 86.1869–12(d).

(iv) Full size pickup truck credits earned according to the provisions of § 86.1870–12(c).

(v) CO_2-equivalent debits for N_2O and/or CH_4 accumulated according to the provisions of § 86.1818–12(f)(4).

(6) Unused CO_2 credits generally retain their full value through five model years after the model year in which they were generated. Credits remaining at the end of the fifth model year after the model year in which they were generated may not be used to demonstrate compliance for later model years. The following particular provisions apply for passenger cars and light trucks:

(i) Unused CO_2 credits from the 2009 model year shall retain their full value through the 2014 model year. Credits from the 2009 model year that remain at the end of the 2014 model year may not be used to demonstrate compliance for later model years.

(ii) Unused CO_2 credits from the 2010 through 2015 model years shall retain their full value through the 2021 model year. Credits remaining from these model years at the end of the 2021 model year may not be used to demonstrate compliance for later model years.

(7) Credits may be used as follows:

(i) Credits generated and calculated according to the method in paragraphs (k)(4) and (5) of this section may not be used to offset deficits other than those deficits accrued within the respective averaging set, except that credits may be transferred between the passenger automobile and light truck fleets of a given manufacturer. Credits may be banked and used in a future model year in which a manufacturer's average CO_2 level exceeds the applicable standard. Credits may also be traded to another manufacturer according to the provisions in paragraph (k)(8) of this section. Before trading or carrying over credits to the next model year, a manufacturer must apply available credits to offset any deficit, where the deadline to offset that credit deficit has not yet passed. This paragraph (k)(7)(i) applies for MDPV, but not for other HDV.

(ii) The use of credits shall not change Selective Enforcement Auditing or in-use testing failures from a failure to a non-failure. The enforcement of the averaging standard occurs through the vehicle's certificate of conformity as described in paragraph (k)(8) of this section. A manufacturer's certificate of conformity is conditioned upon compliance with the averaging provisions. The certificate will be void ab initio if a manufacturer fails to meet the corporate average standard and does not obtain appropriate credits to cover its shortfalls in that model year or subsequent model years (see deficit carry-forward provisions in paragraph (k)(8) of this section).

(iii) The following provisions apply for passenger automobiles and light trucks under the Temporary Leadtime Allowance Alternative Standards:

(A) Credits generated by vehicles subject to the fleet average CO_2 standards specified in § 86.1818–12(c) may only be used to offset a deficit generated by vehicles subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e).

(B) Credits generated by a passenger automobile or light truck averaging set subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e)(4)(i) or (ii) of this section may be used to offset a deficit generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards through the 2015 model year, except that manufacturers qualifying under the provisions of § 86.1818–12(e)(3) may use such credits to offset a deficit generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards through the 2016 model year.

(C) Credits generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e)(4)(i) or (ii) of this section may not be used to offset a deficit generated by an averaging set subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(2) or (3) or otherwise transferred to an averaging set subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(2) or (3).

(D) Credits generated by vehicles subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e)(4)(i) or (ii) may be banked for use in a future model year (to offset a deficit generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards). All such credits may not be used to demonstrate compliance for model year 2016 and later vehicles, except that manufacturers qualifying under the provisions of § 86.1818–12(e)(3) may use such credits to offset a deficit generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards through the 2016 model year.

(E) A manufacturer with any vehicles subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e)(4)(i) or (ii) of this section in a model year in which that manufacturer also generates credits with vehicles subject to the fleet average CO_2 standards specified in § 86.1818–12(c) may not trade or bank credits earned against the fleet average standards in § 86.1818–12(c) for use in a future model year.

(iv) Credits generated in the 2017 through 2020 model years under the provisions of § 86.1818–12(e)(3)(ii) may not be traded or otherwise provided to another manufacturer.

(v) Credits generated under any alternative fleet average standards approved under § 86.1818–12(g) may not be traded or otherwise provided to another manufacturer.

(8) The following provisions apply if a manufacturer calculates that it has negative credits (also called ''debits'' or a ''credit deficit'') for a given model year:

(i) The manufacturer may carry the credit deficit forward into the next three model years. Such a carry-forward may only occur after the manufacturer exhausts any supply of banked credits. The deficit must be covered with an appropriate number of credits that the manufacturer generates or purchases by the end of the third model year. Any remaining deficit is subject to a voiding of the certificate ab initio, as described in this paragraph (k)(8). Manufacturers are not permitted to have a credit deficit for four consecutive years.

(ii) If the credit deficit is not offset within the specified time period, the number of vehicles not meeting the fleet average CO_2 standards (and therefore not covered by the certificate) must be calculated.

(A) Determine the negative credits for the noncompliant vehicle category by multiplying the total megagram deficit by 1,000,000 and then dividing by the mileage specified in paragraph (k)(4) of this section.

(B) Divide the result by the fleet average standard applicable to the model year in which the debits were first incurred and round to the nearest whole number to determine the number of vehicles not meeting the fleet average CO_2 standards.

(iii) EPA will determine the vehicles not covered by a certificate because the condition on the certificate was not satisfied by designating vehicles in those test groups with the highest carbon-related exhaust emission values first and continuing until reaching a number of vehicles equal to the calculated number of non-complying vehicles as determined in this paragraph (k)(8). The same approach applies for HDV, except that EPA will make these designations by ranking test groups based on CO_2 emission values. If these calculations determines that only a portion of vehicles in a test group contribute to the debit situation, then EPA will designate actual vehicles in that test group as not covered by the certificate, starting with the last vehicle produced and counting backwards.

(iv)(A) If a manufacturer ceases production of passenger automobiles, light trucks, or heavy-duty vehicles, the manufacturer continues to be responsible for offsetting any debits outstanding within the required time period. Any failure to offset the debits will be considered a violation of paragraph (k)(8)(i) of this section and may subject the manufacturer to an enforcement action for sale of vehicles not covered by a certificate, pursuant to paragraphs (k)(8)(ii) and (iii) of this section.

(B) If a manufacturer is purchased by, merges with, or otherwise combines with another manufacturer, the controlling entity is responsible for offsetting any debits outstanding within the required time period. Any failure to offset the debits will be considered a violation of paragraph (k)(8)(i) of this section and may subject the manufacturer to an enforcement action for sale of vehicles not covered by a certificate, pursuant to paragraphs (k)(8)(ii) and (iii) of this section.

(v) For purposes of calculating the statute of limitations, a violation of the requirements of paragraph (k)(8)(i) of this section, a failure to satisfy the conditions upon which a certificate(s) was issued and hence a sale of vehicles not covered by the certificate, all occur upon the expiration of the deadline for offsetting debits specified in paragraph (k)(8)(i) of this section.

(9) The following provisions apply to CO_2 credit trading:

(i) EPA may reject CO_2 credit trades if the involved manufacturers fail to submit the credit trade notification in the annual report.

(ii) A manufacturer may not sell credits that are no longer valid for demonstrating compliance based on the model years of the subject vehicles, as specified in paragraph (k)(6) of this section.

(iii) In the event of a negative credit balance resulting from a transaction, both the buyer and seller are liable for the credit shortfall. EPA may void ab initio the certificates of conformity of all test groups that generate or use credits in such a trade.

(iv) (A) If a manufacturer trades a credit that it has not generated pursuant to paragraph (k) of this section or acquired from another party, the manufacturer will be considered to have generated a debit in the model year that the manufacturer traded the credit. The manufacturer must offset such debits by the deadline for the annual report for that same model year.

(B) Failure to offset the debits within the required time period will be considered a failure to satisfy the conditions upon which the certificate(s) was issued and will be addressed pursuant to paragraph (k)(8) of this section.

(v) A manufacturer may only trade credits that it has generated pursuant to paragraphs (k)(4) and (5) of this section or acquired from another party.

(l) *Maintenance of records and submittal of information relevant to compliance with fleet average CO_2 standards*—(1) *Maintenance of records.* (i) Manufacturers producing any light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, or other heavy-duty vehicles subject to the provisions in this subpart must establish, maintain, and retain all the following information in adequately organized records for each model year:

(A) Model year.

(B) Applicable fleet average CO_2 standards for each averaging set as defined in paragraph (i) of this section.

(C) The calculated fleet average CO_2 value for each averaging set as defined in paragraph (i) of this section.

(D) All values used in calculating the fleet average CO_2 values.

(ii) Manufacturers must establish, maintain, and retain all the following information in adequately organized records for each vehicle produced that is subject to the provisions in this subpart:

(A) Model year.

(B) Applicable fleet average CO_2 standard.

(C) EPA test group.

(D) Assembly plant.

(E) Vehicle identification number.

(F) Carbon-related exhaust emission standard (automobile and light truck only), N_2O emission standard, and CH_4 emission standard to which the vehicle is certified.

(G) In-use carbon-related exhaust emission standard for passenger automobiles and light truck, and in-use CO_2 standard for HDV.

(H) Information on the point of first sale, including the purchaser, city, and state.

(iii) Manufacturers must retain all required records for a period of eight years from the due date for the annual report. Records may be stored in any format and on any media, as long as manufacturers can promptly send EPA organized written records in English if requested by the Administrator. Manufacturers must keep records readily available as EPA may review them at any time.

(iv) The Administrator may require the manufacturer to retain additional records or submit information not specifically required by this section.

(v) Pursuant to a request made by the Administrator, the manufacturer must submit to the Administrator the information that the manufacturer is required to retain.

(vi) EPA may void ab initio a certificate of conformity for vehicles certified to emission standards as set forth or otherwise referenced in this subpart for which the manufacturer fails to retain the records required in this section or to provide such information to the Administrator upon request, or to submit the reports required in this section in the specified time period.

(2) *Reporting.* (i) Each manufacturer must submit an annual report. The annual report must contain for each applicable CO_2 standard, the calculated fleet average CO_2 value, all values required to calculate the CO_2 emissions value, the number of credits generated or debits incurred, all the values required to calculate the credits or debits, and the resulting balance of credits or debits. For each applicable alternative N_2O and/or CH_4 standard selected under the provisions of § 86.1818–12(f)(3) for passenger automobiles and light trucks (or § 86.1819–14(c) for HDV), the report must contain the CO_2-equivalent debits for N_2O and/or CH_4 calculated according to § 86.1818–12(f)(4) (or § 86.1819–14(c) for HDV) for each test group and all values required to calculate the number of debits incurred.

(ii) For each applicable fleet average CO_2 standard, the annual report must also include documentation on all credit transactions the manufacturer has engaged in since those included in the last report. Information for each transaction must include all of the following:

(A) Name of credit provider.

(B) Name of credit recipient.

(C) Date the trade occurred.

(D) Quantity of credits traded in megagrams.

(E) Model year in which the credits were earned.

(iii) Manufacturers calculating air conditioning leakage and/or efficiency credits under paragraph § 86.1871–12(b) shall include the following information for each model year and separately for passenger automobiles and light trucks and for each air conditioning system used to generate credits:

(A) A description of the air conditioning system.

(B) The leakage credit value and all the information required to determine this value.

(C) The total credits earned for each averaging set, model year, and region, as applicable.

(iv) Manufacturers calculating advanced technology vehicle credits under paragraph § 86.1871–12(c) shall include the following information for each model year and separately for passenger automobiles and light trucks:

(A) The number of each model type of eligible vehicle sold.

(B) The cumulative model year production of eligible vehicles starting with the 2009 model year.

(C) The carbon-related exhaust emission value by model type and model year.

(v) Manufacturers calculating off-cycle technology credits under paragraph § 86.1871–12(d) shall include, for each model year and separately for passenger automobiles and light trucks, all test results and data required for calculating such credits.

(vi) Unless a manufacturer reports the data required by this section in the annual production report required under § 86.1844–01(e) or the annual report required under § 600.512–12 of this chapter, a manufacturer must submit an annual report for each model year after production ends for all affected vehicles produced by the manufacturer subject to the provisions of this subpart and no later than May 1 of the calendar year following the given model year. Annual reports must be submitted to: Director, Compliance Division, U.S. Environmental Protection Agency, 2000 Traverwood Dr., Ann Arbor, Michigan 48105.

(vii) Failure by a manufacturer to submit the annual report in the specified time period for all vehicles subject to the provisions in this section is a violation of section 203(a)(1) of the Clean Air Act (42 U.S.C. 7522(a)(1)) for each applicable vehicle produced by that manufacturer.

(viii) If EPA or the manufacturer determines that a reporting error occurred on an annual report previously submitted to EPA, the manufacturer's credit or debit calculations will be recalculated. EPA may void erroneous credits, unless traded, and will adjust erroneous debits. In the case of traded erroneous credits, EPA must adjust the selling manufacturer's credit balance to reflect the sale of such credits and any resulting credit deficit.

(3) *Notice of opportunity for hearing.* Any voiding of the certificate under paragraph (l)(1)(vi) of this section will be made only after EPA has offered the affected manufacturer an opportunity for a hearing conducted in accordance with 40 CFR part 1068, subpart G, and, if a manufacturer requests such a hearing, will be made only after an initial decision by the Presiding Officer.

■ 70. Section 86.1866–12 is amended by adding introductory text and revising paragraph (b) introductory text to read as follows:

§ 86.1866–12 CO_2 credits for advanced technology vehicles.

This section describes how to apply CO_2 credits for advanced technology passenger automobiles and light trucks (including MDPV). This section does not apply for heavy-duty vehicles that are not MDPV.

* * * * *

(b) For electric vehicles, plug-in hybrid electric vehicles, fuel cell vehicles, dedicated natural gas vehicles, and dual-fuel natural gas vehicles as those terms are defined in § 86.1803–01, that are certified and produced for U.S. sale in the 2017 through 2021 model years and that meet the additional specifications in this section, the manufacturer may use the production multipliers in this paragraph (b) when determining the manufacturer's fleet average carbon-related exhaust emissions under § 600.510–12 of this chapter. Full size pickup trucks eligible for and using a production multiplier are not eligible for the performance-based credits described in § 86.1870–12(b).

* * * * *

■ 71. Section 86.1867–12 is amended by revising the introductory text to read as follows:

§ 86.1867–12 CO_2 credits for reducing leakage of air conditioning refrigerant.

Manufacturers may generate credits applicable to the CO_2 fleet average program described in § 86.1865–12 by implementing specific air conditioning system technologies designed to reduce air conditioning refrigerant leakage over the useful life of their passenger automobiles and/or light trucks (including MDPV); only the provisions of paragraph (a) this section apply for non-MDPV heavy-duty vehicles. Credits shall be calculated according to this section for each air conditioning system that the manufacturer is using to generate CO_2 credits. Manufacturers may also generate early air conditioning refrigerant leakage credits under this section for the 2009 through 2011 model years according to the provisions of § 86.1871–12(b).

* * * * *

■ 72. Section 86.1868–12 is amended by revising the introductory text and paragraphs (e)(5), (f)(1), (g)(1), and (g)(3) introductory text to read as follows:

§ 86.1868–12 CO_2 credits for improving the efficiency of air conditioning systems.

Manufacturers may generate credits applicable to the CO_2 fleet average program described in § 86.1865–12 by implementing specific air conditioning system technologies designed to reduce air conditioning-related CO_2 emissions over the useful life of their passenger automobiles and/or light trucks (including MDPV). The provisions of this section do not apply for non-MDPV heavy-duty vehicles. Credits shall be calculated according to this section for each air conditioning system that the manufacturer is using to generate CO_2 credits. Manufacturers may also generate early air conditioning efficiency credits under this section for the 2009 through 2011 model years according to the provisions of § 86.1871–12(b). For model years 2012 and 2013 the manufacturer may determine air conditioning efficiency credits using the requirements in paragraphs (a) through (d) of this section. For model years 2014 through 2016 the eligibility requirements specified in either paragraph (e) or (f) of this section must be met before an air conditioning system is allowed to generate credits. For model years 2017 through 2019 the eligibility requirements specified in paragraph (f) of this section must be met before an air conditioning system is allowed to generate credits. For model years 2020 and later the eligibility requirements specified in paragraph (g) of this section must be met before an air conditioning system is allowed to generate credits.

* * * * *

(e) * * *

(5) Air conditioning systems with compressors that are solely powered by electricity shall submit Air Conditioning Idle Test Procedure data to be eligible to generate credits in the 2014 and later model years, but such systems are not required to meet a specific threshold to be eligible to generate such credits, as long as the engine remains off for a period of at least 2 cumulative minutes during the air conditioning on portion of the Idle Test Procedure in § 86.165–12(d).

(f) * * *

(1) The manufacturer shall perform the AC17 test specified in 40 CFR 1066.845 on each unique air conditioning system design and vehicle platform combination (as those terms are defined in § 86.1803) for which the manufacturer intends to accrue air conditioning efficiency credits. The manufacturer must test at least one unique air conditioning system within each vehicle platform in a model year, unless all unique air conditioning systems within a vehicle platform have been previously tested. A unique air conditioning system design is a system with unique or substantially different component designs or types and/or system control strategies (*e.g.,* fixed displacement vs. variable displacement compressors, orifice tube vs. thermostatic expansion valve, single vs. dual evaporator, etc.). In the first year of such testing, the tested vehicle configuration shall be the highest production vehicle configuration within each platform. In subsequent model years the manufacturer must test other unique air conditioning systems within the vehicle platform, proceeding from the highest production untested system until all unique air conditioning systems within the platform have been tested, or until the vehicle platform experiences a major redesign. Whenever a new unique air conditioning system is tested, the highest production configuration using that system shall be the vehicle selected for testing. Air conditioning system designs which have similar cooling capacity, component types, and control strategies, yet differ in terms of compressor pulley ratios or condenser or evaporator surface areas will not be considered to be unique system designs. The test results from one unique system design may represent all variants of that design. Manufacturers must use good engineering judgment to identify the unique air conditioning system designs which will require AC17 testing in subsequent model years. Results must be reported separately for all four phases (two phases with air conditioning off and two phases with air conditioning on) of the test to the Environmental Protection Agency, and the results of the calculations required in 40 CFR 1066.845 must also be reported. In each subsequent model year additional air conditioning system designs, if such systems exist, within a vehicle platform that is generating air conditioning credits must be tested using the AC17 procedure. When all unique air conditioning system designs within a platform have been tested, no additional testing is required within that platform, and credits may be carried over to subsequent model years until there is a significant change in the platform design, at which point a new sequence of testing must be initiated. No more than one vehicle from each credit-generating platform is required to be tested in each model year.

* * * * *

(g) * * *

(1) For each air conditioning system (as defined in § 86.1803) selected by the manufacturer to generate air conditioning efficiency credits, the manufacturer shall perform the AC17 Air Conditioning Efficiency Test Procedure specified in 40 CFR 1066.845, according to the requirements of this paragraph (g).

* * * * *

(3) For the first model year for which an air conditioning system is expected to generate credits, the manufacturer must select for testing the projected highest-selling configuration within each combination of vehicle platform and air conditioning system (as those terms are defined in § 86.1803). The manufacturer must test at least one unique air conditioning system within each vehicle platform in a model year, unless all unique air conditioning systems within a vehicle platform have been previously tested. A unique air conditioning system design is a system with unique or substantially different component designs or types and/or system control strategies (*e.g.,* fixed-displacement vs. variable displacement compressors, orifice tube vs. thermostatic expansion valve, single vs. dual evaporator, etc.). In the first year of such testing, the tested vehicle configuration shall be the highest production vehicle configuration within each platform.

In subsequent model years the manufacturer must test other unique air conditioning systems within the vehicle platform, proceeding from the highest production untested system until all unique air conditioning systems within the platform have been tested, or until the vehicle platform experiences a major redesign. Whenever a new unique air conditioning system is tested, the highest production configuration using that system shall be the vehicle selected for testing. Credits may continue to be generated by the air conditioning system installed in a vehicle platform provided that:

* * * * *

■ 73. Section 86.1869–12 is amended by adding introductory text and revising paragraphs (b)(2) introductory text, (b)(4)(ii), and (f) to read as follows:

§ 86.1869–12 CO_2 credits for off-cycle CO_2-reducing technologies.

This section describes how manufacturers may generate credits for off-cycle CO_2-reducing technologies. The provisions of this section do not apply for non-MDPV heavy-duty vehicles, except that § 86.1819–14(d)(13) describes how to apply paragraphs (c) and (d) this section for those vehicles.

* * * * *

(b) * * *

(2) The maximum allowable decrease in the manufacturer's combined passenger automobile and light truck fleet average CO_2 emissions attributable

to use of the default credit values in paragraph (b)(1) of this section is 10 grams per mile. If the total of the CO_2 g/mi credit values from paragraph (b)(1) of this section does not exceed 10 g/mi for any passenger automobile or light truck in a manufacturer's fleet, then the total off-cycle credits may be calculated according to paragraph (f) of this section. If the total of the CO_2 g/mi credit values from paragraph (b)(1) of this section exceeds 10 g/mi for any passenger automobile or light truck in a manufacturer's fleet, then the gram per mile decrease for the combined passenger automobile and light truck fleet must be determined according to paragraph (b)(2)(i) of this section to determine whether the 10 g/mi limitation has been exceeded.

* * * * *

(4) * * *

(ii) *High efficiency exterior lighting* means a lighting technology that, when installed on the vehicle, is expected to reduce the total electrical demand of the exterior lighting system when compared to conventional lighting systems. To be eligible for this credit, the high efficiency lighting must be installed in one or more of the following lighting components: Low beam, high beam, parking/position, front and rear turn signals, front and rear side markers, taillights, and/or license plate lighting.

* * * * *

(f) *Calculation of total off-cycle credits.* Total off-cycle credits in Megagrams of CO_2 (rounded to the nearest whole number) shall be calculated separately for passenger automobiles and light trucks according to the following formula:

Total Credits (Megagrams) = (Credit × Production × VLM) ÷ 1,000,000

Where:

Credit = the credit value in grams per mile determined in paragraph (b), (c) or (d) of this section.

Production = The total number of passenger automobiles or light trucks, whichever is applicable, produced with the off-cycle technology to which to the credit value determined in paragraph (b), (c), or (d) of this section applies.

VLM = vehicle lifetime miles, which for passenger automobiles shall be 195,264 and for light trucks shall be 225,865.

■ 74. Section 86.1870–12 is amended by revising the section heading, introductory text, and paragraph (a) introductory text and adding paragraph (a)(3) to read as follows:

§ 86.1870–12 CO_2 credits for qualifying full-size light pickup trucks.

Full-size pickup trucks may be eligible for additional credits based on the implementation of hybrid technologies or on exhaust emission performance, as described in this section. Credits may be generated under either paragraph (a) or (b) of this section for a qualifying pickup truck, but not both. The provisions of this section do not apply for heavy-duty vehicles.

(a) *Credits for implementation of hybrid electric technology.* Full size pickup trucks that implement hybrid electric technologies may be eligible for an additional credit under this paragraph (a). Pickup trucks earning the credits under this paragraph (a) may not earn the credits described in paragraph (b) of this section. To claim this credit, the manufacturer must measure the recovered energy over the Federal Test Procedure according to 40 CFR 600.116–12(d) to determine whether a vehicle is a mild or strong hybrid electric vehicle. To provide for EPA testing, the vehicle must be able to broadcast battery pack voltage via an on-board diagnostics parameter ID channel.

* * * * *

(3) If you produce both mild and strong hybrid electric full size pickup trucks but do not qualify for credits under paragraph (a)(1) or (2) of this section, your hybrid electric full size pickup trucks may be eligible for a credit of 10 grams/mile. To receive this credit in a given model year, you must produce a quantity of hybrid electric full size pickup trucks such that the proportion of combined mild and strong full size hybrid electric pickup trucks produced in a model year, when compared to your total production of full size pickup trucks, is not less than the required minimum percentages specified in paragraph (a)(1) of this section.

* * * * *

■ 75. Section 86.1871–12 is amended by revising the introductory text and paragraphs (a) introductory text, (b)(1), and (d) to read as follows:

§ 86.1871–12 Optional early CO_2 credit programs.

Manufacturers may optionally generate CO_2 credits in the 2009 through 2011 model years for use in the 2012 and later model years subject to EPA approval and to the provisions of this section. The provisions of § 86.1819–14(j)(1) apply instead of the provisions of this section for non-MDPV heavy-duty vehicles. Manufacturers may generate early fleet average credits, air conditioning leakage credits, air conditioning efficiency credits, early advanced technology credits, and early off-cycle technology credits. Manufacturers generating any credits under this section must submit an early credits report to the Administrator as required in this section. The terms ''sales'' and ''sold'' as used in this section shall mean vehicles produced for U.S. sale, where ''U.S.'' means the states and territories of the United States. The expiration date of unused CO_2 credits is based on the model year in which the credits are earned, as described in § 86.1865–12(k)(6).

(a) *Early fleet average CO_2 reduction credits.* Manufacturers may optionally generate credits for reductions in their fleet average CO_2 emissions achieved in the 2009 through 2011 model years. To generate early fleet average CO_2 reduction credits, manufacturers must select one of the four pathways described in paragraphs (a)(1) through (4) of this section. The manufacturer may select only one pathway, and that pathway must remain in effect for the 2009 through 2011 model years. Fleet average credits (or debits) must be calculated and reported to EPA for each model year under each selected pathway.

* * * * *

(b) *Early air conditioning leakage and efficiency credits.* (1) Manufacturers may optionally generate air conditioning refrigerant leakage credits according to the provisions of § 86.1867 and/or air conditioning efficiency credits according to the provisions of § 86.1868 in model years 2009 through 2011. Credits must be tracked by model type and model year.

* * * * *

(d) *Early off-cycle technology credits.* Manufacturers may optionally generate credits for the implementation of certain CO_2-reducing technologies according to the provisions of § 86.1869 in model years 2009 through 2011. Credits must be tracked by model type and model year.

* * * * *

Subpart T—Manufacturer-Run In-Use Testing Program for Heavy-Duty Diesel Engines

■ 76. Section 86.1910 is amended by revising paragraph (i) to read as follows:

§ 86.1910 How must I prepare and test my in-use engines?

* * * * *

(i) You may count a vehicle as meeting the vehicle-pass criteria described in § 86.1912 if a shift day of testing or two-shift days of testing (with the requisite non-idle/idle operation time as in paragraph (g) of this section), or if the extended testing you elected under paragraph (h) of this section does not generate a single valid NTE sampling event, as described in § 86.1912(b). Count the vehicle towards meeting your testing requirements under this subpart.

* * * * *

■ 77. Section 86.1912 is revised to read as follows:

§ 86.1912 How do I determine whether an engine meets the vehicle-pass criteria?

In general, the average emissions for each regulated pollutant must remain at or below the NTE threshold in paragraph (a) of this section for at least 90 percent of the valid NTE sampling events, as defined in paragraph (b) of this section. For 2007 through 2009 model year engines, the average emissions from every NTE sampling event must also remain below the NTE thresholds in paragraph (g)(2) of this section. Perform the following steps to determine whether an engine meets the vehicle-pass criteria:

(a) Determine the NTE threshold for each pollutant subject to an NTE standard by adding all three of the following terms and rounding the result to the same number of decimal places as the applicable NTE standard:

(1) The applicable NTE standard.

(2) The in-use compliance testing margin specified in § 86.007–11(h), if any.

(3) An accuracy margin for portable in-use equipment when testing is performed under the special provisions of § 86.1930, depending on the pollutant, as follows:

(i) NMHC: 0.17 g/hp·hr.

(ii) CO: 0.60 g/hp·hr.

(iii) NO_X: 0.50 g/hp·hr.

(iv) PM: 0.10 g/hp·hr.

(v) NO_X + NMHC: 0.67 g/hp·hr.

(4) Accuracy margins for portable in-use equipment when testing is not performed under the special provisions of § 86.1930 for 2007 through 2009 model year engine families that are selected for testing in any calendar year as follows:

(i) NMHC using the emission calculation method specified in 40 CFR 1065.650(a)(1): 0.02 g/hp·hr.

(ii) NMHC using the emission calculation method specified in 40 CFR 1065.650(a)(3): 0.01 g/hp·hr.

(iii) NMHC using an alternative emission calculation method we approve under 40 CFR 1065.915(d)(5)(iv): 0.01 g/hp·hr.

(iv) CO using the emission calculation method specified in 40 CFR 1065.650(a)(1): 0.5 g/hp·hr.

(v) CO using the emission calculation method specified in 40 CFR 1065.650(a)(3): 0.25 g/hp·hr.

(vi) CO using an alternative emission calculation method we approve under 40 CFR 1065.915(d)(5)(iv): 0.25 g/hp·hr.

(vii) NO_X using the emission calculation method specified in 40 CFR 1065.650(a)(1): 0.45 g/hp·hr.

(viii) NO_X using the emission calculation method specified in 40 CFR 1065.650(a)(3): 0.15 g/hp·hr.

(ix) NO_X using an alternative emission calculation method we approve under 40 CFR 1065.915(d)(5)(iv): 0.15 g/hp·hr.

(x) NO_X + NMHC using the emission calculation method specified in 40 CFR 1065.650(a)(1): 0.47 g/hp·hr.

(xi) NO_X + NMHC using the emission calculation method specified in 40 CFR 1065.650(a)(3): 0.16 g/hp·hr.

(xii) NO_X + NMHC using an alternative emission calculation method we approve under 40 CFR 1065.915(d)(5)(iv): 0.16 g/hp·hr.

(xiii) PM: 0.006 g/hp·hr.

(5) Accuracy margins for portable in-use equipment when testing is not performed under the special provisions of § 86.1930 for 2010 or later model year engines families that are selected for testing in any calendar year as follows:

(i) NMHC using any emission calculation method specified in 40 CFR 1065.650(a) or an alternative emission calculation method we approve under 40 CFR 1065.915(d)(5)(iv): 0.01 g/hp·hr.

(ii) CO using any emission calculation method specified in 40 CFR 1065.650(a) or an alternative emission calculation method we approve under 40 CFR 1065.915(d)(5)(iv): 0.25 g/hp·hr.

(iii) NO_X using any emission calculation method specified in 40 CFR 1065.650(a) or an alternative emission calculation method we approve under 40 CFR 1065.915(d)(5)(iv): 0.15 g/hp·hr.

(iv) PM: 0.006 g/hp·hr.

(b) For the purposes of this subpart, a valid NTE sampling event consists of at least 30 seconds of continuous operation in the NTE control area. An NTE event begins when the engine starts to operate in the NTE control area and continues as long as engine operation remains in this area (see § 86.1370). When determining a valid NTE sampling event, exclude all engine operation in approved NTE limited testing regions under § 86.1370–2007(b)(6) and any approved NTE deficiencies under § 86.007–11(a)(4)(iv). Engine operation in the NTE control area of less than 30 contiguous seconds does not count as a valid NTE sampling event; operating periods of less than 30 seconds in the NTE control area, but outside of any allowed deficiency area or limited testing region, will not be added together to make a 30 second or longer event. Exclude any portion of a sampling event that would otherwise exceed the 5.0 percent limit for the time-weighted carve-out defined in § 86.1370–2007(b)(7). For EGR-equipped engines, exclude any operation that occurs during the cold-temperature operation defined by the equations in § 86.1370–2007(f)(1).

(c) Calculate the average emission level for each pollutant over each valid NTE sampling event as specified in 40 CFR part 1065, subpart G, using each NTE event as an individual test interval. This should include valid NTE events from all days of testing.

(d) If the engine has an open crankcase, account for these emissions by adding 0.00042 g/hp·hr to the PM emission result for every NTE event.

(e) Calculate a time-weighted vehicle-pass ratio (R_{pass}) for each pollutant. To do this, first sum the time from each valid NTE sampling event whose average emission level is at or below the NTE threshold for that pollutant, then divide this value by the sum of the engine operating time from all valid NTE events for that pollutant. Round the resulting vehicle-pass ratio to two decimal places.

(1) Calculate the time-weighted vehicle-pass ratio for each pollutant as follows:

$$R_{pass} = \frac{\sum_{m=1}^{n_{pass}} t}{\sum_{k=1}^{n_{total}} t}$$

Where:

n_{pass} = the number of valid sampling events for which the average emission level is at or below the NTE threshold.

n_{total} = the total number of valid NTE sampling events.

(2) For both the numerator and the denominator of the vehicle-pass ratio, use the smallest of the following values for determining the duration, *t*, of any NTE sampling event:

(i) The measured time in the NTE zone that is valid for an NTE sampling event.

(ii) 600 seconds.

(iii) 10 times the length of the shortest valid NTE sampling event for all testing with that engine.

(f) The following example illustrates how to select the duration of NTE sampling events for calculations, as described in paragraph (f) of this section:

NTE sample	Duration of NTE sample (seconds)	Duration limit applied?	Duration used in calculations (seconds)
1	45	No	45
2	168	No	168
3	605	Yes. Use 10 times shortest valid NTE	450
4	490	Yes. Use 10 times shortest valid NTE	450
5	65	No	65

(g) Engines meet the vehicle-pass criteria under this section if they meet both of the following criteria:

(1) The vehicle-pass ratio calculated according to paragraph (e) of this section must be at least 0.90 for each pollutant.

(2) For model year 2007 through 2009 engines, emission levels from every valid NTE sampling event must be less than 2.0 times the NTE thresholds calculated according to paragraph (a) of this section for all pollutants, except that engines certified to a NO_X FEL at or below 0.50 g/hp·hr may meet the vehicle-pass criteria for NO_X if measured NO_X emissions from every valid NTE sample are less than either 2.0 times the NTE threshold for NO_X or 2.0 g/hp·hr, whichever is greater.

■ 78. Section 86.1920 is amended by revising paragraph (b) introductory text to read as follows:

§ 86.1920 What in-use testing information must I report to EPA?

* * * * *

(b) Within 45 days after the end of each calendar quarter, send us reports containing the test data from each engine for which testing was completed during the calendar quarter. Alternatively, you may separately send us the test data within 30 days after you complete testing for an engine. If you request it, we may allow additional time to send us this information. Once you send us information under this section, you need not send that information again in later reports. Prepare your test reports as follows:

* * * * *

Appendix I to Part 86—[Amended]

■ 79. Appendix I to part 86 is amended by removing paragraph (f)(3).

PART 600—FUEL ECONOMY AND GREENHOUSE GAS EXHAUST EMISSIONS OF MOTOR VEHICLES

■ 80. The authority citation for part 600 continues to read as follows:

Authority: 49 U.S.C. 32901–23919q, Pub. L. 109–58.

Subpart A—General Provisions

■ 81. Section 600.002 is amended by revising the definitions for ‘‘Engine code’’, ‘‘Subconfiguration’’, ‘‘Transmission class’’, and ‘‘Vehicle configuration’’ to read as follows:

§ 600.002 Definitions.

* * * * *

Engine code means one of the following:

(1) For LDV, LDT, and MDPV, *engine code* means a unique combination, within an engine-system combination (as defined in § 86.1803 of this chapter), of displacement, fuel injection (or carburetion or other fuel delivery system), calibration, distributor calibration, choke calibration, auxiliary emission control devices, and other engine and emission control system components specified by the Administrator. For electric vehicles, engine code means a unique combination of manufacturer, electric traction motor, motor configuration, motor controller, and energy storage device.

(2) For HDV, *engine code* has the meaning given in § 86.1819–14(d)(12).

* * * * *

Subconfiguration means one of the following:

(1) For LDV, LDT, and MDPV, *subconfiguration* means a unique combination within a vehicle configuration of equivalent test weight, road-load horsepower, and any other operational characteristics or parameters which the Administrator determines may significantly affect fuel economy or CO_2 emissions within a vehicle configuration.

(2) For HDV, *subconfiguration* has the meaning given in § 86.1819–14(d)(12).

* * * * *

Transmission class means a group of transmissions having the following common features: Basic transmission type (*e.g.,* automatic, manual, automated manual, semi-automatic, or continuously variable); number of forward gears used in fuel economy testing (*e.g.,* manual four-speed, three-speed automatic, two-speed semi-automatic); drive system (*e.g.,* front wheel drive, rear wheel drive; four wheel drive), type of overdrive, if applicable (*e.g.,* final gear ratio less than 1.00, separate overdrive unit); torque converter type, if applicable (*e.g.,* non-lockup, lockup, variable ratio); and other transmission characteristics that may be determined to be significant by the Administrator.

* * * * *

Vehicle configuration means one of the following:

(1) For LDV, LDT, and MDPV, *vehicle configuration* means a unique combination of basic engine, engine code, inertia weight class, transmission configuration, and axle ratio within a base level.

(2) For HDV, *vehicle configuration* has the meaning given for ‘‘configuration’’ in § 86.1819–14(d)(12).

Subpart B—Fuel Economy and Carbon-Related Exhaust Emission Test Procedures

■ 82. Section 600.113–12 is amended by revising paragraphs (m), (n) introductory text, (n)(2), and (n)(3) and adding paragraph (o) to read as follows:

§ 600.113–12 Fuel economy, CO_2 emissions, and carbon-related exhaust emission calculations for FTP, HFET, US06, SC03 and cold temperature FTP tests.

* * * * *

(m)(1) For automobiles fueled with liquefied petroleum gas and automobiles designed to operate on gasoline and liquefied petroleum gas, the fuel economy in miles per gallon of liquefied petroleum gas is to be calculated using the following equation:

$$mpg_e = \frac{(CWF_{fuel} \times SG_{fuel} \times 3781.8)}{((CWF_{HC} \times HC) + (0.429 \times CO) + (0.273 \times CO_2))}$$

Where:

mpg_e = miles per gasoline gallon equivalent of liquefied petroleum gas.

CWF_{fuel} = carbon weight fraction based on the hydrocarbon constituents in the liquefied petroleum gas fuel as obtained in paragraph (f)(5) of this section and rounded according to paragraph (g)(3) of this section.

SG = Specific gravity of the fuel as determined in paragraph (f)(5) of this section and rounded according to paragraph (g)(3) of this section.

3781.8 = Grams of H_2O per gallon conversion factor.

CWF_{HC} = Carbon weight fraction of exhaust hydrocarbon = CWF_{fuel} as determined in paragraph (f)(4) of this section and rounded according to paragraph (f)(3) of this section.

HC = Grams/mile HC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

(2)(i) For automobiles fueled with liquefied petroleum gas and automobiles designed to operate on gasoline and liquefied petroleum gas, the carbon-related exhaust emissions in grams per mile while operating on liquefied petroleum gas is to be calculated for 2012 and later model year vehicles using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = (CWF_{HC}/0.273 \times HC) + (1.571 \times CO) + CO_2$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002.

CWF_{HC} = Carbon weight fraction of exhaust hydrocarbon = CWF_{fuel} as determined in paragraph (f)(5) of this section and rounded according to paragraph (g)(3) of this section.

HC = Grams/mile HC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818 of this chapter, the carbon-related exhaust emissions in grams per mile for 2012 and later model year automobiles fueled with liquefied petroleum gas and automobiles designed to operate on mixtures of gasoline and liquefied petroleum gas while operating on liquefied petroleum gas is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = [(CWF_{exHC}/0.273) \times NMHC] + (1.571 \times CO) + CO_2 + (298 \times N_2O) + (25 \times CH_4)$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002.

CWF_{HC} = Carbon weight fraction of exhaust hydrocarbon = CWF_{fuel} as determined in paragraph (f)(5) of this section and rounded according to paragraph (g)(3) of this section.

NMHC = Grams/mile HC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

N_2O = Grams/mile N_2O as obtained in paragraph (g)(2) of this section.

CH_4 = Grams/mile CH_4 as obtained in paragraph (g)(2) of this section.

(n) Manufacturers shall determine CO_2 emissions and carbon-related exhaust emissions for electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles according to the provisions of this paragraph (n). Subject to the limitations on the number of vehicles produced and delivered for sale as described in § 86.1866 of this chapter, the manufacturer may be allowed to use a value of 0 grams/mile to represent the emissions of fuel cell vehicles and the proportion of electric operation of a electric vehicles and plug-in hybrid electric vehicles that is derived from electricity that is generated from sources that are not onboard the vehicle, as described in paragraphs (n)(1) through (3) of this section. For purposes of labeling under this part, the CO_2 emissions for electric vehicles shall be 0 grams per mile. Similarly, for purposes of labeling under this part, the CO_2 emissions for plug-in hybrid electric vehicles shall be 0 grams per mile for the proportion of electric operation that is derived from electricity that is generated from sources that are not onboard the vehicle. For manufacturers no longer eligible to use 0 grams per mile to represent electric operation, and for all 2026 and later model year electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles, the provisions of this paragraph (n) shall be used to determine the non-zero value for CREE for purposes of meeting the greenhouse gas emission standards described in § 86.1818 of this chapter.

* * * * *

(2) For plug-in hybrid electric vehicles the carbon-related exhaust emissions in grams per mile is to be calculated according to the provisions of § 600.116, except that the CREE for charge-depleting operation shall be the sum of the CREE associated with gasoline consumption and the net upstream CREE determined according to paragraph (n)(1) of this section, rounded to the nearest one gram per mile.

(3) For 2012 and later model year fuel cell vehicles, the carbon-related exhaust emissions in grams per mile shall be calculated using the method specified in paragraph (n)(1) of this section, except that $CREE_{UP}$ shall be determined according to procedures established by the Administrator under § 600.111–08(f). As described in § 86.1866 of this chapter the value of CREE may be set equal to zero for a certain number of 2012 through 2025 model year fuel cell vehicles.

(o) Equations for fuels other than those specified in this section may be used with advance EPA approval. Alternate calculation methods for fuel economy and carbon-related exhaust emissions may be used in lieu of the methods described in this section if shown to yield equivalent or superior results and if approved in advance by the Administrator.

■ 83. Section 600.116–12 is amended as follows:

■ a. By revising paragraph (c)(1) introductory text.

■ b. By redesignating paragraphs (c)(2) through (9) as paragraphs (c)(3) through (10), respectively.

■ c. By adding a new paragraph (c)(2).

■ d. By revising newly redesignated paragraph (c)(4).

■ e. By revising newly redesignated paragraph (c)(5) introductory text.

■ f. By revising paragraphs (d)(1)(i)(C), (d)(1)(ii), (d)(2)(ii), and (d)(3).

The revisions and addition read as follows:

§ 600.116–12 Special procedures related to electric vehicles and hybrid electric vehicles.

* * * * *

(c) * * *

(1) To determine CREE values to demonstrate compliance with GHG standards, calculate composite values representing combined operation during charge-depleting and charge-sustaining operation using the following utility factors except as specified in this paragraph (c):

* * * * *

(2) Determine fuel economy values to demonstrate compliance with CAFE standards as follows:

(i) For vehicles that do not qualify as dual fueled automobiles under 49 CFR 538.5, determine fuel economy using the utility factors described in paragraph (c)(1) of this section. Do not use the petroleum-equivalence factors described in 10 CFR 474.3.

(ii) For vehicles that qualify as dual fueled automobiles under 49 CFR 538.5, determine fuel economy based on the procedure described in paragraph (c)(2)(i) of this section, or based on the following equation, separately for city and highway driving:

$$MPGe_{CAFE} = \frac{1}{\left(\frac{0.5}{MPG_{gas}} + \frac{0.5}{MPG_{elec}}\right)}$$

Where:

MPG_{gas} = The miles per gallon measured while operating on gasoline during charge-sustaining operation as determined using the procedures of SAE J1711 (incorporated by reference in § 600.011).

$MPGe_{elec}$ = The miles per gallon equivalent measured while operating on electricity.

Calculate this value by dividing the equivalent all-electric range determined from the equation in § 86.1866–12(b)(2)(ii) by the corresponding measured Watt-hours of energy consumed; apply the appropriate petroleum-equivalence factor from 10 CFR 474.3 to convert Watt-hours to gallons equivalent. Note that if vehicles use no gasoline during charge-depleting operation, $MPGe_{elec}$ is the same as the charge-depleting fuel economy specified in SAE J1711.

* * * * *

(4) You may calculate performance values under paragraphs (c)(1) through (3) of this section by combining phases during FTP testing. For example, you may treat the first 7.45 miles as a single phase by adding the individual utility factors for that portion of driving and assigning emission levels to the combined phase. Do this consistently throughout a test run.

(5) Instead of the utility factors specified in paragraphs (c)(1) through (3) of this section, calculate utility factors using the following equation for vehicles whose maximum speed is less than the maximum speed specified in the driving schedule, where the vehicle's maximum speed is determined, to the nearest 0.1 mph, from observing the highest speed over the first duty cycle (FTP, HFET, etc.):

* * * * *

(d) * * *

(1) * * *

(i) * * *

(C) Determine braking power in kilowatts using the following equation. Note that during braking events, P_{brake}, P_{accel}, and $P_{roadload}$ will all be negative (*i.e.,* resistive) forces on the vehicle.

$$P_{brake} = P_{accel} - P_{roadload}$$

Where:

P_{accel} = the value determined in paragraph (d)(1)(i)(B) of this section;

$P_{roadload}$ = the value determined in paragraph (d)(1)(i)(A) of this section; and

P_{brake} = 0 if P_{accel} is greater than or equal to $P_{roadload}$.

(ii) The total maximum braking energy (E_{brake}) that could theoretically be recovered is equal to the absolute value of the sum of all the values of P_{brake} determined in paragraph (d)(1)(i)(C) of this section, divided by 36000 (to convert 10 Hz data to hours) and rounded to the nearest 0.01 kilowatt-hours.

(2) * * *

(ii) At each sampling point where current is flowing into the battery, calculate the energy flowing into the battery, in Watt-hours, as follows:

$$E_t = \frac{I_t \cdot V_{nominal}}{36,000}$$

Where:

E_t = the energy flowing into the battery, in Watt-hours, at time t in the test;

I_t = the electrical current, in Amps, at time *t* in the test; and

$V_{nominal}$ = the nominal voltage of the hybrid battery system determined according to paragraph (d)(4) of this section.

* * * * *

(3) The percent of braking energy recovered by a hybrid system relative to the total available energy is determined by the following equation, rounded to the nearest one percent:

$$\text{Energy Recovered \%} = \frac{E_{rec}}{E_{brake}} \cdot 100$$

Where:

E_{rec} = The actual total energy recovered, in kilowatt-hours, as determined in paragraph (d)(2) of this section; and

E_{brake} = The theoretical maximum amount of energy, in kilowatt-hours, that could be recovered by a hybrid electric vehicle over the FTP test cycle, as determined in paragraph (d)(1) of this section.

* * * * *

Subpart C—Procedures for Calculating Fuel Economy and Carbon-Related Exhaust Emission Values

■ 84. Section 600.208–12 is amended by revising paragraph (a)(2)(iii) to read as follows:

§ 600.208–12 Calculation of FTP-based and HFET-based fuel economy, CO_2 emissions, and carbon-related exhaust emissions for a model type.

(a) * * *

(2) * * *

(iii) All subconfigurations within the new base level are represented by test data in accordance with § 600.010(c)(1)(iii).

* * * * *

■ 85. Section 600.210–12 is amended by revising paragraph (c)(2)(iv)(C) to read as follows:

§ 600.210–12 Calculation of fuel economy and CO_2 emission values for labeling.

* * * * *

(c) * * *

(2) * * *

(iv) * * *

(C) Calculate a composite city CO_2 emission rate and a composite highway CO_2 emission rate by combining the separate results for battery and engine operation using the procedures described in § 600.116. Use these values to calculate the vehicle's combined CO_2 emissions as described in paragraph (c)(2)(i) of this section.

* * * * *

Subpart F—Procedures for Determining Manufacturer's Average Fuel Economy and Manufacturer's Average Carbon-Related Exhaust Emissions

■ 86. Section 600.510–12 is amended by revising paragraph (h) to read as follows:

§ 600.510–12 Calculation of average fuel economy and average carbon-related exhaust emissions.

* * * * *

(h) The increase in average fuel economy determined in paragraph (c) of this section attributable to dual fueled automobiles is subject to a maximum value that applies separately to each category of automobile specified in paragraph (a)(1) of this section. The increase in average fuel economy attributable to vehicles fueled by electricity or, for model years 2016 and later, by compressed natural gas, is not subject to a maximum value. The following maximum values apply under this paragraph (h):

Model year	Maximum increase (mpg)
1993–2014	1.2
2015	1.0
2016	0.8
2017	0.6
2018	0.4
2019	0.2
2020 and later	0.0

(1) The Administrator shall calculate the increase in average fuel economy to determine if the maximum increase provided in this paragraph (h) has been reached. The Administrator shall calculate the increase in average fuel economy for each category of automobiles specified in paragraph (a)(1) of this section by subtracting the average fuel economy values calculated in accordance with this section, assuming all alcohol dual fuel automobiles are operated exclusively on

gasoline (or diesel fuel), from the average fuel economy values determined in paragraph (c) of this section. The difference is limited to the maximum increase specified in this paragraph (h).

(2) [Reserved]

* * * * *

PART 1033—CONTROL OF EMISSIONS FROM LOCOMOTIVES

■ 87. The authority citation for part 1033 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart A—Overview and Applicability

■ 88. Section 1033.1 is amended by revising paragraph (e) to read as follows:

§ 1033.1 Applicability.

* * * * *

(e) The provisions of this part apply as specified for locomotives manufactured or remanufactured on or after July 7, 2008. See § 1033.102 to determine whether the standards of this part or the standards specified in Appendix I of this part apply for model years 2008 through 2012. For example, for a locomotive that was originally manufactured in 2007 and remanufactured on April 10, 2014, the provisions of this part begin to apply on April 10, 2014.

■ 89. Section 1033.30 is revised to read as follows:

§ 1033.30 Submission of information.

Unless we specify otherwise, send all reports and requests for approval to the Designated Compliance Officer (see § 1033.901). See § 1033.925 for additional reporting and recordkeeping provisions.

Subpart B—Emission Standards and Related Requirements

■ 90. Section 1033.101 is amended by revising paragraphs (f)(1)(ii) and (f)(2)(i) and (iii) to read as follows:

§ 1033.101 Exhaust emission standards.

* * * * *

(f) * * *

(1) * * *

(ii) Gaseous-fueled locomotives: NMHC emissions. This includes dual-fuel and flexible-fuel locomotives that use a combination of a gaseous fuel and a nongaseous fuel.

* * * * *

(2) * * *

(i) Certify your Tier 4 and later diesel-fueled locomotives for operation with only Ultra Low Sulfur Diesel (ULSD) fuel. Use ULSD as the test fuel for these locomotives. You may alternatively certify Tier 4 and later locomotives using Low Sulfur Diesel Fuel (LSD).

* * * * *

(iii) Certify your Tier 3 and earlier diesel-fueled locomotives for operation with either ULSD fuel or LSD fuel if they do not include sulfur-sensitive technology or if you demonstrate compliance using an LSD test fuel (including commercial LSD fuel).

* * * * *

■ 91. Section 1033.102 is revised to read as follows:

§ 1033.102 Transition to the standards specified in this subpart.

(a) Except as specified in § 1033.150(a), the Tier 0 and Tier 1 standards of § 1033.101 apply for new locomotives beginning January 1, 2010, except as specified in § 1033.150(a). The Tier 0 and Tier 1 standards specified in Appendix I of this part apply for earlier model years.

(b) Except as specified in § 1033.150(a), the Tier 2 standards of § 1033.101 apply for new locomotives beginning January 1, 2013. The Tier 2 standards specified in Appendix I of this part apply for earlier model years.

(c) The Tier 3 and Tier 4 standards of § 1033.101 apply for the model years specified in that section.

■ 92. Section 1033.120 is amended by revising paragraph (b) to read as follows:

§ 1033.120 Emission-related warranty requirements.

* * * * *

(b) *Warranty period.* Except as specified in this paragraph, the minimum warranty period is one-third of the useful life. Your emission-related warranty must be valid for at least as long as the minimum warranty periods listed in this paragraph (b) in MW-hrs of operation (or miles for Tier 0 locomotives not equipped with MW-hr meters) and years, whichever comes first. You may offer an emission-related warranty more generous than we require. The emission-related warranty for the locomotive may not be shorter than any basic mechanical warranty you provide without charge for the locomotive. Similarly, the emission-related warranty for any component may not be shorter than any warranty you provide without charge for that component. This means that your warranty may not treat emission-related and nonemission-related defects differently for any component. If you provide an extended warranty to individual owners for any components covered in paragraph (c) of this section for an additional charge, your emission-related warranty must cover those components for those owners to the same degree. If the locomotive does not record MW-hrs, we base the warranty periods in this paragraph (b) only on years. The warranty period begins when the locomotive is placed into service, or back into service after remanufacture.

* * * * *

■ 93. Section 1033.1135 is amended by revising paragraph (b)(3) to read as follows:

§ 1033.135 Labeling.

* * * * *

(b) * * *

(3) Label diesel-fueled locomotives near the fuel inlet to identify the allowable fuels, consistent with § 1033.101. For example, Tier 4 locomotives with sulfur sensitive technology (or that otherwise require ULSD for compliance) should be labeled ''ULTRA LOW SULFUR DIESEL FUEL ONLY''. You do not need to label Tier 3 and earlier locomotives certified for use with both LSD and ULSD.

* * * * *

Subpart C—Certifying Engine Families

■ 94. Section 1033.201 is amended by revising paragraphs (a) and (g) to read as follows:

§ 1033.201 General requirements for obtaining a certificate of conformity.

* * * * *

(a) You must send us a separate application for a certificate of conformity for each engine family. A certificate of conformity is valid for new production from the indicated effective date, until the end of the model year for which it is issued, which may not extend beyond December 31 of that year. No certificate will be issued after December 31 of the model year. You may amend your application for certification after the end of the model year in certain circumstances as described in §§ 1033.220 and 1033.225. You must renew your certification annually for any locomotives you continue to produce.

* * * * *

(g) We may require you to deliver your test locomotives (including test engines, as applicable) to a facility we designate for our testing (see § 1033.235(c)). Alternatively, you may choose to deliver another engine/locomotive that is identical in all material respects to the test locomotive, or another engine/locomotive that we determine can appropriately serve as an emission-data locomotive for the engine family.

* * * * *

■ 95. Section 1033.225 is amended by revising the introductory text and adding paragraph (b)(4) to read as follows:

§ 1033.225 Amending applications for certification.

Before we issue you a certificate of conformity, you may amend your application to include new or modified locomotive configurations, subject to the provisions of this section. After we have issued your certificate of conformity, but before the end of the model year, you may send us an amended application requesting that we include new or modified locomotive configurations within the scope of the certificate, subject to the provisions of this section. Before the end of the model year, you must also amend your application if any changes occur with respect to any information that is included or should be included in your application. For example, you must amend your application if you determine that your actual production variation for an adjustable parameter exceeds the tolerances specified in your application. After the end of the model year, you may amend your application only to update maintenance instructions as described in § 1033.220 or to modify an FEL as described in paragraph (f) of this section.

* * * * *

(b) * * *

(4) Include any other information needed to make your application correct and complete.

* * * * *

■ 96. Section 1033.235 is amended by revising paragraphs (b), (c)(4), and (d)(1) to read as follows:

§ 1033.235 Emission testing required for certification.

* * * * *

(b) Test your emission-data locomotives using the procedures and equipment specified in subpart F of this part. In the case of dual-fuel locomotives, measure emissions when operating with each type of fuel for which you intend to certify the locomotive. In the case of flexible-fuel locomotives, measure emissions when operating with the fuel mixture that best represents in-use operation or is most likely to have the highest NO_X emissions, though you may ask us instead to perform tests with both fuels separately if you can show that intermediate mixtures are not likely to occur in use.

(c) * * *

(4) Before we test one of your locomotives, we may calibrate it within normal production tolerances for anything we do not consider an adjustable parameter. For example, this would apply for a parameter that is subject to production variability because it is adjustable during production, but is not considered an adjustable parameter (as defined in § 1033.901) because it is permanently sealed.

(d) * * *

(1) The engine family from the previous model year differs from the current engine family only with respect to model year, items identified in § 1033.225(a), or other factors not related to emissions. We may waive this criterion for differences we determine not to be relevant.

* * * * *

■ 97. Section 1033.245 is amended by revising the introductory text and paragraph (b) introductory text and adding paragraphs (b)(3) through (5) to read as follows:

§ 1033.245 Deterioration factors.

Establish deterioration factors for each pollutant to determine whether your locomotives will meet emission standards for each pollutant throughout the useful life, as described in § 1033.240. Determine deterioration factors as described in this section, either with an engineering analysis, with pre-existing test data, or with new emission measurements. The deterioration factors are intended to reflect the deterioration expected to result during the useful life of a locomotive maintained as specified in § 1033.125. If you perform durability testing, the maintenance that you may perform on your emission-data locomotive is limited to the maintenance described in § 1033.125. You may carry across a deterioration factor from one engine family to another consistent with good engineering judgment.

* * * * *

(b) Apply deterioration factors as follows:

* * * * *

(3) *Sawtooth deterioration patterns.* The deterioration factors described in paragraphs (b)(1) and (2) of this section assume that the highest useful life emissions occur either at the end of useful life or at the low-hour test point. The provisions of this paragraph (b)(3) apply where good engineering judgment indicates that the highest emissions over the useful life will occur between these two points. For example, emissions may increase with service accumulation until a certain maintenance step is performed, then return to the low-hour emission levels and begin increasing again. Base deterioration factors for locomotives with such emission patterns on the difference between (or ratio of) the point of the sawtooth at which the highest emissions occur and the low-hour test point. Note that this applies for maintenance-related deterioration only where we allow such critical emission-related maintenance.

(4) *Dual-fuel and flexible-fuel engines.* In the case of dual-fuel and flexible-fuel locomotives, apply deterioration factors separately for each fuel type by measuring emissions with each fuel type at each test point. You may accumulate service hours on a single emission-data engine using the type of fuel or the fuel mixture expected to have the highest combustion and exhaust temperatures; you may ask us to approve a different fuel mixture if you demonstrate that a different criterion is more appropriate.

(5) *Deterioration factor for crankcase emissions.* If your engine vents crankcase emissions to the exhaust or to the atmosphere, you must account for crankcase emission deterioration, using good engineering judgment. You may use separate deterioration factors for crankcase emissions of each pollutant (either multiplicative or additive) or include the effects in combined deterioration factors that include exhaust and crankcase emissions together for each pollutant.

* * * * *

■ 98. Section 1033.250 is amended by revising paragraphs (b)(3)(iv) and (c) to read as follows:

§ 1033.250 Reporting and recordkeeping.

* * * * *

(b) * * *

(3) * * *

(iv) All your emission tests (valid and invalid), including the date and purpose of each test and documentation of test parameters as specified in part 40 CFR part 1065, and the date and purpose of each test.

* * * * *

(c) Keep required data from emission tests and all other information specified in this section for eight years after we issue your certificate. If you use the same emission data or other information for a later model year, the eight-year period restarts with each year that you continue to rely on the information.

* * * * *

■ 99. Section 1033.255 is amended by revising paragraphs (c)(2), (c)(4), (d), and (e) to read as follows:

§ 1033.255 EPA decisions.

* * * * *

(c) * * *

(2) Submit false or incomplete information (paragraph (e) of this section applies if this is fraudulent).

This includes doing anything after submission of your application to render any of the submitted information false or incomplete.

* * * * *

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

* * * * *

(d) We may void the certificate of conformity for an engine family if you fail to keep records, send reports, or give us information as required under this part or the Act. Note that these are also violations of 40 CFR 1068.101(a)(2).

(e) We may void your certificate if we find that you intentionally submitted false or incomplete information. This includes rendering submitted information false or incomplete after submission.

* * * * *

Subpart F—Test Procedures

■ 100. Section 1033.501 is amended by revising paragraph (a)(3) and adding paragraphs (a)(4), (a)(5), and (j) to read as follows:

§ 1033.501 General provisions.

(a) * * *

(3) The following provisions apply for engine mapping, duty cycle generation, and cycle validation to account for the fact that locomotive operation and locomotive duty cycles are based on operator demand from locomotive notch settings, not on target values for engine speed and load:

(i) The provisions related to engine mapping, duty cycle generation, and cycle validation in 40 CFR 1065.510, 1065.512, and 1065.514 do not apply for testing complete locomotives.

(ii) The provisions related to engine mapping and duty cycle generation in 40 CFR 1065.510 and 1065.512 are not required for testing with an engine dynamometer; however, the cycle validation criteria of 40 CFR 1065.514 apply for such testing. Demonstrate compliance with cycle validation criteria based on manufacturer-declared values for maximum torque, maximum power, and maximum test speed, or determine these values from an engine map generated according to 40 CFR 1065.510. If you test using a ramped-modal cycle, you may perform cycle validation over all the test intervals together.

(4) If you perform discrete-mode testing and use only one batch fuel measurement to determine your mean raw exhaust flow rate, you must target a constant sample flow rate over the mode. Verify proportional sampling as described in 40 CFR 1065.545 using the mean raw exhaust molar flow rate paired with each recorded sample flow rate.

(5) If you perform discrete-mode testing by grouping the modes in the same manner as the test intervals of the ramped modal cycle using three different dilution settings for the groups, as allowed in § 1033.515(c)(5)(ii), you may verify proportional sampling over each phase instead of each discrete mode.

* * * * *

(j) The following provisions apply for locomotives using aftertreatment technology with infrequent regeneration events that may occur during testing:

(1) Adjust measured emissions to account for aftertreatment technology with infrequent regeneration as described in § 1033.535.

(2) Invalidate a smoke test if active regeneration starts to occur during the test.

■ 101. Section 1033.515 is amended by revising paragraphs (c)(2)(ii) and (c)(5)(ii) to read as follows:

§ 1033.515 Discrete-mode steady-state emission tests of locomotives and locomotive engines.

* * * * *

(c) * * *

(2) * * *

(ii) The sample period is 300 seconds for all test modes except mode 8. The sample period for test mode 8 is 600 seconds.

* * * * *

(5) * * *

(ii) Group the modes in the same manner as the test intervals of the ramped modal cycle and use three different dilution settings for the groups. Use one setting for both idle modes, one for dynamic brake through Notch 5, and one for Notch 6 through Notch 8. For each group, ensure that the mode with the highest exhaust flow (typically normal idle, Notch 5, and Notch 8) meets the criteria for minimum dilution ratio in 40 CFR part 1065.

* * * * *

■ 102. Section 1033.520 is revised to read as follows:

§ 1033.520 Alternative ramped modal cycles.

(a) Locomotive testing over a ramped modal cycle is intended to improve measurement accuracy at low emission levels by allowing the use of batch sampling of PM and gaseous emissions over multiple locomotive notch settings. Ramped modal cycles combine multiple test modes of a discrete-mode steady-state into a single sample period. Time in notch is varied to be proportional to weighting factors. The ramped modal cycle for line-haul locomotives is shown in Table 1 to this section. The ramped modal cycle for switch locomotives is shown in Table 2 to this section. Both ramped modal cycles consist of a warm-up followed by three test intervals that are each weighted in a manner that maintains the duty cycle weighting of the line-haul and switch locomotive duty cycles in § 1033.530. You may use ramped modal cycle testing for any locomotives certified under this part.

(b) Ramped modal testing requires continuous gaseous analyzers and three separate PM filters (one for each test interval). You may collect a single batch sample for each test interval, but you must also measure gaseous emissions continuously to allow calculation of notch caps as required under § 1033.101.

(c) You may operate the engine in any way you choose to warm it up. Then follow the provisions of 40 CFR part 1065, subpart F for general pre-test procedures (including engine and sampling system pre-conditioning).

(d) Begin the test by operating the locomotive over the pre-test portion of the cycle. For locomotives not equipped with catalysts, you may begin the test as soon as the engine reaches its lowest idle setting. For catalyst-equipped locomotives, you may begin the test in normal idle mode if the engine does not reach its lowest idle setting within 15 minutes. If you do start in normal idle, run the low idle mode after normal idle, then resume the specified mode sequence (without repeating the normal idle mode).

(e) Start the test according to 40 CFR 1065.530.

(1) Each test interval begins when operator demand is set to the first operator demand setting of each test interval of the ramped modal cycle. Each test interval ends when the time in mode is reached for the last mode in the test interval.

(2) For PM emissions (and other batch sampling), the sample period over which emissions for the test interval are averaged generally begins within 10 seconds after the operator demand is changed to start the test interval and ends within 5 seconds of the sampling time for the test mode is reached (see Table 1 to this section). You may ask to delay the start of the sample period to account for sample system residence times longer than 10 seconds.

(3) Use good engineering judgment when transitioning between test intervals.

(i) You should come as close as possible to simultaneously:

(A) Ending batch sampling of the previous test interval.

(B) Starting batch sampling of the next test interval.

(C) Changing the operator demand to the notch setting for the first mode in the next test interval.

(ii) Avoid the following:

(A) Overlapping batch sampling of the two test intervals.

(B) An unnecessarily long delay before starting the next test interval.

(iii) For example, the following sequence would generally be appropriate:

(A) End batch sampling for Interval 2 after 304 seconds in Notch 5.

(B) Switch the operator demand to Notch 6 one second later.

(C) Begin batch sampling for Interval 3 one second after switching to Notch 6.

(4) If applicable, begin the smoke test at the start of the first test test interval of the applicable ramped modal cycle. Continue collecting smoke data until the completion of final test interval. Refer to § 1033.101 to determine applicability of the smoke standards and § 1033.525 for details on how to conduct a smoke test.

(5) Proceed through each test interval of the applicable ramped modal cycle in the order specified until the test is completed.

(6) If you must void a test interval, you may repeat it. To do so, begin with a warm engine operating at the notch setting for the last mode in the previous test interval. You do not need to repeat later test intervals if they were valid. (**Note:** you must report test results for all voided tests and test test intervals.)

(7) Following the completion of the third test test interval of the applicable ramped modal cycle, conduct the post-test sampling procedures specified in 40 CFR 1065.530.

(f) Calculate your cycle-weighted brake-specific emission rates as follows:

(1) For each test interval j:

(i) Calculate emission rates (E_{ij}) for each pollutant i as the total mass emissions divided by the total time in the test interval.

(ii) Calculate average power (P_j) as the total work divided by the total time in the test interval.

(2) For each pollutant, calculate your cycle-weighted brake-specific emission rate using the following equation, where w_j is the weighting factor for test interval j:

$$E_{ij} = \frac{w_1 E_{i1} + w_2 E_{i2} + w_3 E_{i3}}{w_1 P_1 + w_2 PSUB2 + w_3 P_3}$$

(g) The following tables define applicable ramped modal cycles for line-haul and switch locomotives:

TABLE 1 TO § 1033.520—LINE-HAUL LOCOMOTIVE RAMPED MODAL CYCLE

RMC test interval	Weighting factor	RMC mode	Time in mode (seconds)	Notch setting
Pre-test idle	NA	NA	600 to 900	Lowest idle setting.[1]
Interval 1 (Idle test)	0.380	A	600	Low Idle.[2]
		B	600	Normal Idle.
Interval Transition				
Interval 2	0.389	C	1,000	Dynamic Brake.[3]
		1	520	Notch 1.
		2	520	Notch 2.
		3	416	Notch 3.
		4	352	Notch 4.
		5	304	Notch 5.
Interval Transition				
Interval 3	0.231	6	144	Notch 6.
		7	111	Notch 7.
		8	600	Notch 8.

[1] See paragraph (d) of this section for alternate pre-test provisions.
[2] Operate at normal idle for modes A and B if not equipped with multiple idle settings.
[3] Operate at normal idle if not equipped with a dynamic brake.

TABLE 2 TO § 1033.520—SWITCH LOCOMOTIVE RAMPED MODAL CYCLE

RMC test interval	Weighting factor	RMC mode	Time in mode (seconds)	Notch setting
Pre-test idle	NA	NA	600 to 900	Lowest idle setting.[1]
Interval 1 (Idle test)	0.598	A	600	Low Idle.[2]
		B	600	Normal Idle.
Interval Transition				
Interval 2	0.377	1	868	Notch 1.
		2	861	Notch 2.
		3	406	Notch 3.
		4	252	Notch 4.
		5	252	Notch 5.
Interval Transition				
Interval 3	0.025	6	1,080	Notch 6.
		7	144	Notch 7.

TABLE 2 TO § 1033.520—SWITCH LOCOMOTIVE RAMPED MODAL CYCLE—Continued

RMC test interval	Weighting factor	RMC mode	Time in mode (seconds)	Notch setting
		8	576	Notch 8.

[1] See paragraph (d) of this section for alternate pre-test provisions.
[2] Operate at normal idle for modes A and B if not equipped with multiple idle settings.

■ 103. Section 1033.535 is revised to read as follows:

§ 1033.535 Adjusting emission levels to account for infrequently regenerating aftertreatment devices.

For locomotives using aftertreatment technology with infrequent regeneration events that may occur during testing, take one of the following approaches to account for the emission impact of regeneration:

(a) You may use the calculation methodology described in 40 CFR 1065.680 to adjust measured emission results. Do this by developing an upward adjustment factor and a downward adjustment factor for each pollutant based on measured emission data and observed regeneration frequency as follows:

(1) Adjustment factors should generally apply to an entire engine family, but you may develop separate adjustment factors for different configurations within an engine family. Use the adjustment factors from this section for all testing for the engine family.

(2) You may use carryover or carry-across data to establish adjustment factors for an engine family as described in § 1033.235, consistent with good engineering judgment.

(3) Determine the frequency of regeneration, *F*, as described in 40 CFR 1065.680 from in-use operating data or from running repetitive tests in a laboratory. If the engine is designed for regeneration at fixed time intervals, you may apply good engineering judgment to determine *F* based on those design parameters.

(4) Identify the value of *F* in each application for the certification for which it applies.

(5) Apply the provisions for ramped-modal testing based on measurements for each test interval rather than the whole ramped-modal test.

(b) You may ask us to approve an alternate methodology to account for regeneration events. We will generally limit approval to cases where your engines use aftertreatment technology with extremely infrequent regeneration and you are unable to apply the provisions of this section.

(c) You may choose to make no adjustments to measured emission results if you determine that regeneration does not significantly affect emission levels for an engine family (or configuration) or if it is not practical to identify when regeneration occurs. If you choose not to make adjustments under paragraph (a) or (b) of this section, your locomotives must meet emission standards for all testing, without regard to regeneration.

Subpart G—Special Compliance Provisions

■ 104. Section 1033.601 is amended by adding paragraph (f) to read as follows:

§ 1033.601 General compliance provisions.

* * * * *

(f) *Multi-fuel locomotives.* Subpart C of this part describes how to test and certify dual-fuel and flexible-fuel locomotives. Some multi-fuel locomotives may not fit either of those defined terms. For such locomotives, we will determine whether it is most appropriate to treat them as single-fuel locomotives, dual-fuel locomotives, or flexible-fuel locomotives based on the range of possible and expected fuel mixtures. For example, a locomotive might burn natural gas but initiate combustion with a pilot injection of diesel fuel. If the locomotive is designed to operate with a single fueling algorithm (*i.e.,* fueling rates are fixed at a given engine speed and load condition), we would generally treat it as a single-fuel locomotive, In this context, the combination of diesel fuel and natural gas would be its own fuel type. If the locomotive is designed to also operate on diesel fuel alone, we would generally treat it as a dual-fueled locomotive. If the locomotive is designed to operate on varying mixtures of the two fuels, we would generally treat it as a flexible-fueled locomotive. To the extent that requirements vary for the different fuels or fuel mixtures, we may apply the more stringent requirements.

Subpart H—Averaging, Banking, and Trading for Certification

■ 105. Section 1033.701 is amended by adding paragraph (k) to read as follows:

§ 1033.701 General provisions.

* * * * *

(k) You may use either of the following approaches to retire or forego emission credits:

(1) You may retire emission credits generated from any number of your locomotives. This may be considered donating emission credits to the environment. Identify any such credits in the reports described in § 1033.730. Locomotives must comply with the applicable FELs even if you donate or sell the corresponding emission credits under this paragraph (e). Those credits may no longer be used by anyone to demonstrate compliance with any EPA emission standards.

(2) You may certify a family using an FEL below the emission standard as described in this part and choose not to generate emission credits for that family. If you do this, you do not need to calculate emission credits for those families and you do not need to submit or keep the associated records described in this subpart for that family.

■ 106. Section 1033.710 is amended by revising paragraph (c) to read as follows:

§ 1033.710 Averaging emission credits.

* * * * *

(c) If you certify an engine family to an FEL that exceeds the otherwise applicable emission standard, you must obtain enough emission credits to offset the engine family's deficit by the due date for the final report required in § 1033.730. The emission credits used to address the deficit may come from your other engine families that generate emission credits in the same model year, from emission credits you have banked from previous model years, or from emission credits generated in the same or previous model years that you obtained through trading or by transfer.

■ 107. Section 1033.725 is amended by revising paragraph (b)(2) to read as follows:

§ 1033.725 Requirements for your application for certification.

* * * * *

(b) * * *

(2) Detailed calculations of projected emission credits (positive or negative) based on projected production volumes. We may require you to include similar calculations from your other engine families to demonstrate that you will be able to avoid negative credit balances

for the model year. If you project negative emission credits for a family, state the source of positive emission credits you expect to use to offset the negative emission credits.

■ 108. Section 1033.730 is amended by revising paragraphs (b)(1), (b)(4), and (c)(2) to read as follows:

§ 1033.730 ABT reports.

* * * * *

(b) * * *

(1) Engine family designation and averaging sets (whether switch, line-haul, or both).

* * * * *

(4) The projected and actual U.S.-directed production volumes for the model year as described in § 1033.705. If you changed an FEL during the model year, identify the actual U.S.-directed production volume associated with each FEL.

* * * * *

(c) * * *

(2) State whether you will retain any emission credits for banking. If you choose to retire emission credits that would otherwise be eligible for banking, identify the engine families that generated the emission credits, including the number of emission credits from each family.

* * * * *

■ 109. Section 1033.735 is amended by revising paragraphs (a) and (b) to read as follows:

§ 1033.735 Required records.

(a) You must organize and maintain your records as described in this section.

(b) Keep the records required by this section for at least eight years after the due date for the end-of-year report. You may not use emission credits for any engines if you do not keep all the records required under this section. You must therefore keep these records to continue to bank valid credits.

* * * * *

Subpart I—Requirements for Owners and Operators

■ 110. Section 1033.815 is amended by revising paragraphs (b) and (e) introductory text to read as follows:

§ 1033.815 Maintenance, operation, and repair.

* * * * *

(b) Perform unscheduled maintenance in a timely manner. This includes malfunctions identified through the locomotive's emission control diagnostics system and malfunctions discovered in components of the diagnostics system itself. For most repairs, this paragraph (b) requires that the maintenance be performed no later than the locomotive's next periodic (92-day or 184-day) inspection. See paragraph (e) of this section, for reductant replenishment requirements in a locomotive equipped with an SCR system.

* * * * *

(e) For locomotives equipped with emission controls requiring the use of specific fuels, lubricants, or other fluids, proper maintenance includes complying with the manufacturer/remanufacturer's specifications for such fluids when operating the locomotives. This requirement applies without regard to whether misfueling permanently disables the emission controls. For locomotives certified on ultra-low sulfur diesel fuel, but that do not include sulfur-sensitive emission controls, you may use low-sulfur diesel fuel instead of ultra-low sulfur diesel fuel, consistent with good engineering judgment. The following additional provisions apply for locomotives equipped with SCR systems requiring the use of urea or other reductants:

* * * * *

Subpart J—Definitions and Other Reference Information

■ 111. Section 1033.901 is amended as follows:

■ a. By revising the definition for ''Designated Compliance Officer''.

■ b. By adding definitions for ''Dual-fuel'' and ''Flexible-fuel''.

■ c. By revising the definitions for ''Remanufacture system or remanufacturing system'' and ''Total hydrocarbon equivalent''.

The revisions and addition read as follows:

§ 1033.901 Definitions.

* * * * *

Designated Compliance Officer means the Director, Diesel Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *complianceinfo@epa.gov; epa.gov/otaq/verify*.

* * * * *

Dual-fuel means relating to a locomotive designed for operation on two different fuels but not on a continuous mixture of those fuels (see § 1033.601(f)). For purposes of this part, such a locomotive remains a dual-fuel locomotive even if it is designed for operation on three or more different fuels.

* * * * *

Flexible-fuel means relating to a locomotive designed for operation on any mixture of two or more different fuels (see § 1033.601(f)).

* * * * *

Remanufacture system or *remanufacturing system* means all components (or specifications for components) and instructions necessary to remanufacture a locomotive or locomotive engine in accordance with applicable requirements of this part.

* * * * *

Total hydrocarbon equivalent has the meaning given in 40 CFR 1065.1001. This generally means the sum of the carbon mass contributions of non-oxygenated hydrocarbon, alcohols and aldehydes, or other organic compounds that are measured separately as contained in a gas sample, expressed as exhaust hydrocarbon from petroleum-fueled locomotives. The atomic hydrogen-to-carbon ratio of the equivalent hydrocarbon is 1.85:1.

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■ 112. Section 1033.915 is revised to read as follows:

§ 1033.915 Confidential information.

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

■ 113. Section 1033.925 is revised to read as follows:

§ 1033.925 Reporting and recordkeeping requirements.

(a) This part includes various requirements to submit and record data or other information. Unless we specify otherwise, store required records in any format and on any media and keep them readily available for eight years after you send an associated application for certification, or eight years after you generate the data if they do not support an application for certification. You are expected to keep your own copy of required records rather than relying on someone else to keep records on your behalf. We may review these records at any time. You must promptly send us organized, written records in English if we ask for them. We may require you to submit written records in an electronic format.

(b) The regulations in § 1033.255, 40 CFR 1068.25, and 40 CFR 1068.101 describe your obligation to report truthful and complete information. This includes information not related to certification. Failing to properly report information and keep the records we specify violates 40 CFR 1068.101(a)(2), which may involve civil or criminal penalties.

(c) Send all reports and requests for approval to the Designated Compliance Officer (see § 1033.801).

(d) Any written information we require you to send to or receive from another company is deemed to be a required record under this section. Such records are also deemed to be submissions to EPA. We may require you to send us these records whether or not you are a certificate holder.

(e) Under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*), the Office of Management and Budget approves the reporting and recordkeeping specified in the applicable regulations. Failing to properly report information and keep the records we specify violates 40 CFR 1068.101(a)(2), which may involve civil or criminal penalties. The following items illustrate the kind of reporting and recordkeeping we require for locomotives regulated under this part:

(1) We specify the following requirements related to locomotive certification in this part 1033:

(i) In § 1033.150 we state the requirements for interim provisions.

(ii) In subpart C of this part we identify a wide range of information required to certify engines.

(iii) In § 1033.325 we specify certain records related to production-line testing.

(iv) In subpart G of this part we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various special compliance provisions.

(v) In §§ 1033.725, 1033.730, and 1033.735 we specify certain records related to averaging, banking, and trading.

(vi) In subpart I of this part we specify certain records related to meeting requirements for remanufactured engines.

(2) We specify the following requirements related to testing in 40 CFR part 1065:

(i) In 40 CFR 1065.2 we give an overview of principles for reporting information.

(ii) In 40 CFR 1065.10 and 1065.12 we specify information needs for establishing various changes to published test procedures.

(iii) In 40 CFR 1065.25 we establish basic guidelines for storing test information.

(iv) In 40 CFR 1065.695 we identify the specific information and data items to record when measuring emissions.

(3) We specify the following requirements related to the general compliance provisions in 40 CFR part 1068:

(i) In 40 CFR 1068.5 we establish a process for evaluating good engineering judgment related to testing and certification.

(ii) In 40 CFR 1068.25 we describe general provisions related to sending and keeping information.

(iii) In 40 CFR 1068.27 we require manufacturers to make locomotives available for our testing or inspection if we make such a request.

(iv) In 40 CFR part 1068, subpart C, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various exemptions.

(v) In 40 CFR part 1068, subpart D, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to importing locomotives and engines.

(vi) In 40 CFR 1068.450 and 1068.455 we specify certain records related to testing production-line locomotives in a selective enforcement audit.

(vii) In 40 CFR 1068.501 we specify certain records related to investigating and reporting emission-related defects.

(viii) In 40 CFR 1068.525 and 1068.530 we specify certain records related to recalling nonconforming locomotives.

■ 114. Appendix I to part 1033 is added to read as follows:

Appendix I to Part 1033—Original Standards for Tier 0, Tier 1 and Tier 2 Locomotives

(a) The following emission standards applied for new locomotives not yet subject to this part 1033:

Type of standard	Year of original manufacture	Tier	Standards (g/bhp-hr)		
			NO_X	PM–primary	PM–alternate [a]
Line-haul	1973–1992	Tier 0	9.5	0.60	0.30
	1993–2004	Tier 1	7.4	0.45	0.22
	2005–2011	Tier 2	5.5	0.20	0.10
Switch	1973–1992	Tier 0	14.0	0.72	0.36
	1993–2004	Tier 1	11.0	0.54	0.27
	2005–2011	Tier 2	8.1	0.24	0.12

[a] Locomotives certified to the alternate PM standards are also subject to alternate CO standards of 10.0 for the line-haul cycle and 12.0 for the switch cycle.

(b) The original Tier 0, Tier 1, and Tier 2 standards for HC and CO emissions and smoke are the same standards identified in § 1033.101.

■ 115. Part 1036 is revised to read as follows:

PART 1036—CONTROL OF EMISSIONS FROM NEW AND IN-USE HEAVY-DUTY HIGHWAY ENGINES

Subpart A—Overview and Applicability

Subpart B—Emission Standards and Related Requirements

Subpart C—Certifying Engine Families

Subpart D—Testing Production Engines

Subpart E—In-use Testing

Authority: 42 U.S.C. 7401–7671q.

Subpart A—Overview and Applicability

§ 1036.1 Does this part apply for my engines?

(a) Except as specified in § 1036.5, the provisions of this part apply for engines that will be installed in heavy-duty vehicles above 14,000 pounds GVWR for propulsion. These provisions also apply for engines that will be installed in incomplete heavy-duty vehicles at or below 14,000 pounds GVWR unless the engine is installed in a vehicle that is covered by a certificate of conformity under 40 CFR part 86, subpart S.

(b) This part does not apply with respect to exhaust emission standards for HC, CO, NO_X, or PM except as follows:

(1) The provisions of § 1036.601 apply.

(2) 40 CFR parts 85 and/or 86 may specify that certain provisions apply.

(c) The provisions of this part also apply for fuel conversions of all engines described in paragraph (a) of this section as described in 40 CFR 85.502.

(d) Gas turbine heavy-duty engines and other heavy-duty engines not meeting the definition *compression-ignition* or *spark-ignition* are deemed to be compression-ignition engines for purposes of this part.

§ 1036.2 Who is responsible for compliance?

The regulations in this part 1036 contain provisions that affect both engine manufacturers and others. However, the requirements of this part are generally addressed to the engine manufacturer(s). The term ''you'' generally means the engine manufacturer(s), especially for issues related to certification. Additional requirements and prohibitions apply to other persons as specified in § 1036.601 and 40 CFR part 1068.

§ 1036.5 Which engines are excluded from this part's requirements?

(a) The provisions of this part do not apply to engines used in medium-duty passenger vehicles or other heavy-duty vehicles that are subject to regulation under 40 CFR part 86, subpart S, except as specified in 40 CFR part 86, subpart S, and § 1036.108(a)(4). For example, this exclusion applies for engines used in vehicles certified to the standards of 40 CFR 86.1819.

(b) An engine installed in a heavy-duty vehicle that is not used to propel the vehicle is not a heavy-duty engine. The provisions of this part therefore do not apply to these engines. Note that engines used to indirectly propel the vehicle (such as electrical generator engines that provide power to batteries for propulsion) are subject to this part. See 40 CFR part 1039, 1048, or 1054 for other requirements that apply for these auxiliary engines. See 40 CFR part 1037 for requirements that may apply for vehicles using these engines, such as the evaporative emission requirements of 40 CFR 1037.103.

(c) The provisions of this part do not apply to aircraft or aircraft engines. Standards apply separately to certain aircraft engines, as described in 40 CFR part 87.

(d) The provisions of this part do not apply to engines that are not internal combustion engines. For example, the provisions of this part do not apply to fuel cells.

(e) The provisions of this part do not apply for model year 2013 and earlier heavy-duty engines unless they were voluntarily certified to this part.

§ 1036.10 How is this part organized?

This part 1036 is divided into the following subparts:

(a) Subpart A of this part defines the applicability of this part 1036 and gives an overview of regulatory requirements.

(b) Subpart B of this part describes the emission standards and other requirements that must be met to certify engines under this part. Note that § 1036.150 describes certain interim requirements and compliance provisions that apply only for a limited time.

(c) Subpart C of this part describes how to apply for a certificate of conformity.

(d) [Reserved]

(e) Subpart E of this part describes provisions for testing in-use engines.

(f) Subpart F of this part describes how to test your engines (including references to other parts of the Code of Federal Regulations).

(g) Subpart G of this part describes requirements, prohibitions, and other provisions that apply to engine manufacturers, vehicle manufacturers, owners, operators, rebuilders, and all others.

(h) Subpart H of this part describes how you may generate and use emission credits to certify your engines.

(i) Subpart I of this part contains definitions and other reference information.

§ 1036.15 Do any other regulation parts apply to me?

(a) Part 86 of this chapter describes additional requirements that apply to engines that are subject to this part 1036. This part extensively references portions of 40 CFR part 86. For example, the regulations of part 86 specify emission standards and certification procedures related to criteria pollutants.

(b) Part 1037 of this chapter describes requirements for controlling evaporative emissions and greenhouse gas emissions from heavy-duty vehicles, whether or not they use engines certified under this part. It also includes standards and requirements that apply instead of the standards and requirements of this part in some cases.

(c) Part 1065 of this chapter describes procedures and equipment specifications for testing engines to measure exhaust emissions. Subpart F of this part 1036 describes how to apply the provisions of part 1065 of this chapter to determine whether engines meet the exhaust emission standards in this part.

(d) Certain provisions of part 1068 of this chapter apply as specified in § 1036.601 to everyone, including anyone who manufactures, imports, installs, owns, operates, or rebuilds any of the engines subject to this part 1036, or vehicles containing these engines. Part 1068 of this chapter describes general provisions that apply broadly, but do not necessarily apply for all engines or all persons. See § 1036.601 to determine how to apply the part 1068 regulations for heavy-duty engines. The issues addressed by these provisions include these seven areas:

(1) Prohibited acts and penalties for engine manufacturers, vehicle manufacturers, and others.

(2) Rebuilding and other aftermarket changes.

(3) Exclusions and exemptions for certain engines.

(4) Importing engines.

(5) Selective enforcement audits of your production.

(6) Recall.

(7) Procedures for hearings.

(e) Other parts of this chapter apply if referenced in this part.

§ 1036.30 Submission of information.

Unless we specify otherwise, send all reports and requests for approval to the Designated Compliance Officer (see § 1036.801). See § 1036.825 for additional reporting and recordkeeping provisions.

Subpart B—Emission Standards and Related Requirements

§ 1036.100 Overview of exhaust emission standards.

Engines used in vehicles certified to the applicable chassis standards for greenhouse gases described in 40 CFR 86.1819 are not subject to the standards specified in this part. All other engines subject to this part must meet the greenhouse gas standards in § 1036.108 in addition to the criteria pollutant standards of 40 CFR part 86.

§ 1036.108 Greenhouse gas emission standards.

This section contains standards and other regulations applicable to the emission of the air pollutant defined as the aggregate group of six greenhouse gases: Carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. This section describes the applicable CO_2, N_2O, and CH_4 standards for engines. These standards do not apply for engines used in vehicles subject to (or voluntarily certified to) the CO_2, N_2O, and CH_4 standards for vehicles specified in 40 CFR 86.1819.

(a) *Emission standards.* Emission standards apply for engines measured using the test procedures specified in subpart F of this part as follows:

(1) CO_2 emission standards apply as specified in this paragraph (a)(1). The applicable test cycle for measuring CO_2 emissions differs depending on the engine family's primary intended service class and the extent to which the engines will be (or were designed to be) used in tractors. For medium and heavy heavy-duty engines certified as tractor engines, measure CO_2 emissions using the steady-state duty cycle specified in 40 CFR 86.1362 (referred to as the ramped-modal cycle, or RMC, even though emission sampling involves measurements from discrete modes). This is intended for engines designed to be used primarily in tractors and other line-haul applications. Note that the use of some RMC-certified tractor engines in vocational applications does not affect your certification obligation under this paragraph (a)(1); see other provisions of this part and 40 CFR part 1037 for limits on using engines certified to only one cycle. For medium and heavy heavy-duty engines certified as both tractor and vocational engines, measure CO_2 emissions using the steady-state duty cycle and the transient duty cycle (sometimes referred to as the FTP engine cycle), both of which are specified in 40 CFR part 86, subpart N. This is intended for engines that are designed for use in both tractor and vocational applications. For all other engines (including all spark-ignition engines), measure CO_2 emissions using the appropriate transient duty cycle specified in 40 CFR part 86, subpart N.

(i) The CO_2 standard for model year 2016 and later spark-ignition engines is 627 g/hp-hr.

(ii) The following CO_2 standards apply for compression-ignition engines, including engines that are deemed to be compression-ignition engines under § 1036.1 (in g/hp-hr):

Model years	Light heavy-duty	Medium heavy-duty—vocational	Heavy heavy-duty—vocational	Medium heavy-duty—tractor	Heavy heavy-duty—tractor
2014–2016	600	600	567	502	475
2017–2020	576	576	555	487	460
2021–2023	565	565	544	479	453
2024–2026	556	556	536	469	443
2027 and later	553	553	533	466	441

(2) The CH_4 emission standard is 0.10 g/hp-hr when measured over the applicable transient duty cycle specified in 40 CFR part 86, subpart N. This standard begins in model year 2014 for compression-ignition engines and in model year 2016 for spark-ignition engines. Note that this standard applies for all fuel types just as the other standards of this section do.

(3) N_2O emission standards applies as follows for engines when measured over the appropriate transient duty cycle specified in 40 CFR part 86, subpart N:

(i) An emission standard of 0.05 g/hp-hr applies for model year 2021 and later engines.

(ii) An emission standard of 0.10 g/hp-hr applies for compression-ignition engines for model years 2014 through 2020.

(iii) An emission standard of 0.10 g/hp-hr applies for spark-ignition engines for model years 2016 through 2020.

(b) *Family certification levels.* You must specify a CO_2 Family Certification Level (FCL) for each engine family. The FCL may not be less than the certified emission level for the engine family. The CO_2 Family Emission Limit (FEL) for the engine family is equal to the FCL multiplied by 1.03.

(c) *Averaging, banking, and trading.* You may generate or use emission credits under the averaging, banking, and trading (ABT) program described in subpart H of this part for demonstrating compliance with CO_2 emission standards. Credits (positive and negative) are calculated from the difference between the FCL and the applicable emission standard. As described in § 1036.705, you may use CO_2 credits to certify your engine families to FELs for N_2O and/or CH_4, instead of the N_2O/CH_4 standards of this section that otherwise apply. Except as specified in §§ 1036.150 and 1036.705, you may not generate or use credits for N_2O or CH_4 emissions.

(d) *Useful life.* The exhaust emission standards of this section apply for the full useful life, expressed in service miles, operating hours, or calendar years, whichever comes first. The useful life values applicable to the criteria pollutant standards of 40 CFR part 86 apply for the standards of this section, except that model year 2021 and later spark-ignition engines and light heavy-duty compression-ignition engines are subject to the standards of this section over a useful life of 15 years or 150,000 miles, whichever comes first.

(e) *Applicability for testing.* The emission standards in this subpart apply as specified in this paragraph (e) to all duty-cycle testing (according to the applicable test cycles) of testable configurations, including certification, selective enforcement audits, and in-use testing. The CO_2 FCLs serve as the CO_2 emission standards for the engine family with respect to certification and confirmatory testing instead of the standards specified in paragraph (a)(1) of this section. The FELs serve as the emission standards for the engine family with respect to all other duty-cycle testing. See §§ 1036.235 and 1036.241 to determine which engine configurations within the engine family are subject to testing. Note that fuel maps and powertrain test results also serve as standards as described in § 1036.535, § 1036.630 and 40 CFR 1037.550.

(f) *Multi-fuel engines.* For dual-fuel, multi-fuel, and flexible-fuel engines, perform exhaust testing on each fuel type (for example, gasoline and E85).

(1) This paragraph (f)(1) applies where you demonstrate the relative amount of each fuel type that your engines consume in actual use. Based on your demonstration, we will specify a weighting factor and allow you to submit the weighted average of your emission results. For example, if you certify an E85 flexible-fuel engine and we determine the engine will produce one-half of its work from E85 and one-half of its work from gasoline, you may apply a 50% weighting factor to each of your E85 and gasoline emission results.

(2) If you certify your engine family to N_2O and/or CH_4 FELs the FELs apply for testing on all fuel types for which your engine is designed, to the same extent as criteria emission standards apply.

§ 1036.115 Other requirements.

(a) The warranty and maintenance requirements, adjustable parameter provisions, and defeat device prohibition of 40 CFR part 86 apply with respect to the standards of this part.

(b) You must create a fuel map and establish idle-specific fuel-consumption values for your engine as described in § 1036.535. You may alternatively perform powertrain testing as specified in § 1036.630 and 40 CFR 1037.550 for some or all of your configurations within the engine family.

(c) You must design and produce your engines to comply with evaporative emission standards as follows:

(1) For complete heavy-duty vehicles you produce, you must certify the vehicles to emission standards as specified in 40 CFR 1037.103.

(2) For incomplete heavy-duty vehicles, and for engines used in vehicles you do not produce, you do not need to certify your engines to evaporative emission standards or otherwise meet those standards. However, vehicle manufacturers certifying their vehicles with your engines may depend on you to produce your engines according to their specifications. Also, your engines must meet applicable exhaust emission standards in the installed configuration.

§ 1036.130 Installation instructions for vehicle manufacturers.

(a) If you sell an engine for someone else to install in a vehicle, give the engine installer instructions for installing it consistent with the requirements of this part. Include all information necessary to ensure that an engine will be installed in its certified configuration.

(b) Make sure these instructions have the following information:

(1) Include the heading: ''Emission-related installation instructions''.

(2) State: ''Failing to follow these instructions when installing a certified engine in a heavy-duty motor vehicle violates federal law, subject to fines or other penalties as described in the Clean Air Act.''

(3) Provide all instructions needed to properly install the exhaust system and any other components.

(4) Describe any necessary steps for installing any diagnostic system required under 40 CFR part 86.

(5) Describe how your certification is limited for any type of application. For example, if you certify heavy heavy-duty engines to the CO_2 standards using only steady-state transient FTP testing, you must make clear that the engine may not be installed in tractors.

(6) Describe any other instructions to make sure the installed engine will operate according to design specifications in your application for certification. This may include, for example, instructions for installing aftertreatment devices when installing the engines.

(7) State: ''If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the vehicle, as described in 40 CFR 1068.105.''

(c) Give the vehicle manufacturer fuel map results as described in § 1036.535 or powertrain results as described in § 1036.630 and 40 CFR 1037.550 for each engine configuration, as appropriate.

(d) You do not need installation instructions for engines that you install in your own vehicles.

(e) Provide instructions in writing or in an equivalent format. For example, you may post instructions on a publicly available Web site for downloading or printing. If you do not provide the instructions in writing, explain in your application for certification how you will ensure that each installer is informed of the installation requirements.

§ 1036.135 Labeling.

Label your engines as described in 40 CFR 86.007–35(a)(3), with the following additional information:

(a) [Reserved]

(b) Identify the emission control system. Use terms and abbreviations as described in 40 CFR 1068.45 or other applicable conventions.

(c) Identify any limitations on your certification. For example, if you certify heavy heavy-duty engines to the CO_2 standards using only transient cycle testing, include the statement ''VOCATIONAL VEHICLES ONLY''.

(d) You may ask us to approve modified labeling requirements in this part 1036 if you show that it is necessary or appropriate. We will approve your request if your alternate label is consistent with the requirements of this part. We may also specify modified labeling requirement to be consistent with the intent of 40 CFR part 1037.

§ 1036.140 Primary intended service class and engine cycle.

(a) You must identify a single primary intended service class for each engine family. Select the class that best describes vehicles for which you design and market the engine. There are three primary intended service classes for vehicles with engines that are not gasoline-fueled: Light heavy-duty, medium heavy-duty, and heavy heavy-duty. Unless otherwise specified, engines that qualify as medium heavy-duty or heavy heavy-duty engines and do not operate on gasoline must meet all the emission standards and other requirements of this part that apply for compression-ignition engines, even if they qualify under the definitions as spark-ignition engines. Also, spark-ignition engines that qualify as light heavy-duty engines must meet all the emission standards and other requirements of this part that apply for spark-ignition engines, regardless of fuel. These spark-ignition light-heavy-duty engines and all sizes of gasoline-fueled heavy-duty engines together form a separate primary intended service class. For purposes of this section, dual-fuel and flexible fuel engines that operate on gasoline are considered gasoline-fueled engines.

(b) Divide engines other than gasoline-fueled engines into primary intended service classes based on the following engine and vehicle characteristics:

(1) Light heavy-duty engines usually are not designed for rebuild and do not have cylinder liners. Vehicle body types in this group might include any heavy-duty vehicle built from a light-duty truck chassis, van trucks, multi-stop vans, motor homes and other recreational vehicles, and some straight trucks with a single rear axle. Typical applications would include personal transportation, light-load commercial delivery, passenger service, agriculture, and construction. The GVWR of these vehicles is normally below 19,500 pounds.

(2) Medium heavy-duty engines may be designed for rebuild and may have cylinder liners. Vehicle body types in this group would typically include school buses, straight trucks with dual rear axles, city tractors, and a variety of special purpose vehicles such as small dump trucks, and refuse trucks. Typical applications would include commercial short haul and intra-city delivery and pickup. Engines in this group are normally used in vehicles whose GVWR ranges from 19,500 to 33,000 pounds.

(3) Heavy heavy-duty engines are designed for multiple rebuilds and have cylinder liners. Vehicles in this group are normally tractors, trucks, and buses used in inter-city, long-haul applications. These vehicles normally exceed 33,000 pounds GVWR.

§ 1036.150 Interim provisions.

The provisions in this section apply instead of other provisions in this part.

(a) *Early banking of greenhouse gas emissions.* You may generate CO_2 emission credits for engines you certify in model year 2013 (2015 for spark-ignition engines) to the standards of § 1036.108.

(1) Except as specified in paragraph (a)(2) of this section, to generate early credits, you must certify your entire U.S.-directed production volume within that averaging set to these standards. This means that you may not generate early credits while you produce engines in the averaging set that are certified to the criteria pollutant standards but not to the greenhouse gas standards. Calculate emission credits as described in subpart H of this part relative to the standard that would apply for model year 2014 (2016 for spark-ignition engines).

(2) You may generate early credits for an individual compression-ignition engine family where you demonstrate that you have improved a model year 2013 engine model's CO_2 emissions relative to its 2012 baseline level and certify it to an FCL below the applicable standard. Calculate emission credits as described in subpart H of this part relative to the lesser of the standard that would apply for model year 2014 engines or the baseline engine's CO_2 emission rate. Use the smaller U.S.-directed production volume of the 2013 engine family or the 2012 baseline engine family. We will not allow you to generate emission credits under this paragraph (a)(2) unless we determine that your 2013 engine is the same engine as the 2012 baseline or that it replaces it.

(3) You may bank credits equal to the surplus credits you generate under this paragraph (a) multiplied by 1.50. For example, if you have 10 Mg of surplus credits for model year 2013, you may bank 15 Mg of credits. Credit deficits for an averaging set prior to model year 2014 (2016 for spark-ignition engines) do not carry over to model year 2014 (2016 for spark-ignition engines). We recommend that you notify us of your intent to use this provision before submitting your applications.

(b) *Model year 2014 N_2O standards.* In model year 2014 and earlier, manufacturers may show compliance with the N_2O standards using an engineering analysis. This allowance also applies for later families certified using carryover CO_2 data from model 2014 consistent with § 1036.235(d).

(c) *Engine cycle classification.* Through model year 2020, engines meeting the definition of spark-ignition, but regulated as diesel engines under 40 CFR part 86, must be certified to the requirements applicable to compression-ignition engines under this part. Such engines are deemed to be compression-ignition engines for purposes of this part. Similarly, engines meeting the definition of compression-ignition, but regulated as Otto-cycle under 40 CFR part 86 must be certified to the requirements applicable to spark-ignition engines under this part. Such engines are deemed to be spark-ignition engines for purposes of this part. See § 1036.140 for provisions that apply for model year 2021 and later.

(d) *Small manufacturers.* Standards apply on a delayed schedule for manufacturers meeting the small business criteria specified in 13 CFR 121.201. Apply the small business criteria for NAICS code 336310 for engine manufacturers with respect to gasoline-fueled engines, 333618 for engine manufacturers with respect to other engines, and 811198 with respect to fuel conversions with engines manufactured by a different company. Qualifying manufacturers are not subject to the greenhouse gas emission standards in § 1036.108 for engines built before January 1, 2022. In addition, qualifying manufacturers producing engines that run on any fuel other than gasoline, E85, or diesel fuel may delay complying with every new standard under this part by one model year. Small businesses may certify their engines and generate emission credits under this part 1036 before standards start to apply, but only if they certify their entire U.S.-directed production volume within that averaging set for that model year.

(e) *Alternate phase-in standards.* Where a manufacturer certifies all of its model year 2013 compression-ignition engines within a given primary intended service class to the applicable alternate standards of this paragraph (e), its compression-ignition engines within that primary intended service class are subject to the standards of this paragraph (e) for model years 2013 through 2016. This means that once a manufacturer chooses to certify a primary intended service class to the standards of this paragraph (e), it is not allowed to opt out of these standards. Engines certified to these standards are not eligible for early credits under paragraph (a) of this section.

Tractors	LHD Engines	MHD Engines	HHD Engines
Model Years 2013–2015.	NA	512 g/hp-hr	485 g/hp-hr.

Tractors	LHD Engines	MHD Engines	HHD Engines
Model Years 2016 and later.[a]	NA	487 g/hp-hr	460 g/hp-hr.
Vocational	LHD Engines	MHD Engines	HHD Engines.
Model Years 2013–2015.	618 g/hp-hr	618 g/hp-hr	577 g/hp-hr.
Model Years 2016 and later.[a]	576 g/hp-hr	576 g/hp-hr	555 g/hp-hr.

[a] **Note:** These alternate standards for 2016 and later are the same as the otherwise applicable standards for 2017 and later.

(f) *Separate OBD families.* This paragraph (f) applies where you separately certify engines for the purpose of applying OBD requirements (for engines used in vehicles under 14,000 pounds GVWR) from non-OBD engines that could be certified as a single engine family. You may treat the two engine families as a single engine family in certain respects for the purpose of this part, as follows:

(1) This paragraph (f) applies only where the two families are identical in all respects except for the engine ratings offered and the inclusion of OBD.

(2) For purposes of this part and 40 CFR part 86, the two families remain two separate families except for the following:

(i) Specify the testable configurations of the non-OBD engine family as the testable configurations for the OBD family.

(ii) Submit the same CO_2, N_2O, and CH_4 emission data for both engine families.

(g) *Assigned deterioration factors.* You may use assigned deterioration factors (DFs) without performing your own durability emission tests or engineering analysis as follows:

(1) You may use an assigned additive DF of 0.0 g/hp-hr for CO_2 emissions from engines that do not use advanced or off-cycle technologies. If we determine it to be consistent with good engineering judgment, we may allow you to use an assigned additive DF of 0.0 g/hp-hr for CO_2 emissions from your engines with advanced or off-cycle technologies.

(2) You may use an assigned additive DF of 0.020 g/hp-hr for N_2O emissions from any engine through model year 2020, and 0.010 g/hp-hr for later model years.

(3) You may use an assigned additive DF of 0.020 g/hp-hr for CH_4 emissions from any engine.

(h) *Advanced technology credits.* If you generate credits from model year 2020 and earlier engines certified for advanced technology you may multiply these credits by 1.5, except that you may not apply this multiplier and the early-credit multiplier of paragraph (a) of this section.

(i) *CO_2 credits for low N_2O emissions.* If you certify your model year 2014, 2015, or 2016 engines to an N_2O FEL less than 0.04 g/hp-hr (provided you measure N_2O emissions from your emission-data engines), you may generate additional CO_2 credits under this paragraph (i). Calculate the additional CO_2 credits from the following equation instead of the equation in § 1036.705:

$$CO_2 \text{ Credits (Mg)} = (0.04 - FEL_{N2O}) \cdot (CF) \cdot (Volume) \cdot (UL) \cdot (10^{-6}) \cdot (298)$$

(j) *Alternate standards under 40 CFR part 86.* This paragraph (j) describes alternate emission standards for engines certified under 40 CFR 86.1819–14(k)(8). The standards of § 1036.108 do not apply for these engines. The standards in this paragraph (j) apply for emissions measured with the engine installed in a complete vehicle consistent with the provisions of 40 CFR 86.1819–14(k)(8)(vi). The CO_2 standard for the engines equals the test result specified in 40 CFR 86.1819–14(k)(8)(vi) multiplied by 1.10 and rounded to the nearest 0.1 g/mile. The N_2O and CH_4 standards are both 0.05 g/mile (or any alternate standards that apply to the corresponding vehicle test group). The only requirements of this part that apply to these engines are those in this paragraph (j) and those in §§ 1036.115 through 1036.135.

(k) *ABT reports.* Through model year 2017, you may submit a final report under § 1036.730 up to 270 days after the end of the model year, as long as you send a draft report with the same information within 90 days after the end of the model year.

(l) *Credit adjustment for spark-ignition engines and light heavy-duty compression-ignition engines.* For emission credits generated from model year 2020 and earlier spark-ignition engines and light heavy-duty compression-ignition engines, multiply any banked credits that you carry forward to demonstrate compliance with model year 2021 and later standards by 1.36.

(m) *Infrequent regeneration.* For model year 2020 and earlier, you may invalidate any test interval with respect to CO_2 measurements if an infrequent regeneration event occurs during the test interval.

(n) *Supplying fuel maps.* Certifying engine manufacturers must supply vehicle manufacturers with fuel maps (or powertrain test results) as described in § 1036.130 for model year 2020 engines.

Subpart C—Certifying Engine Families

§ 1036.205 What must I include in my application?

Submit an application for certification as described in 40 CFR 86.007–21, with the following additional information:

(a) Describe the engine family's specifications and other basic parameters of the engine's design and emission controls with respect to compliance with the requirements of this part. Describe in detail all system components for controlling greenhouse gas emissions, including all auxiliary emission control devices (AECDs) and all fuel-system components you will install on any production or test engine. Identify the part number of each component you describe. For this paragraph (a), treat as separate AECDs any devices that modulate or activate differently from each other.

(b) Describe any test equipment and procedures that you used if you performed any tests that did not also involve measurement of criteria pollutants. Describe any special or alternate test procedures you used (see 40 CFR 1065.10(c)).

(c) Include the emission-related installation instructions you will provide if someone else installs your engines in their vehicles (see § 1036.130).

(d) Describe the label information specified in § 1036.135. We may require you to include a copy of the label.

(e) Identify the CO_2 FCLs with which you are certifying engines in the engine family; also identify any FELs that apply for CH_4 and N_2O. The actual U.S.-directed production volume of configurations that have CO_2 emission rates at or below the FCL and CH_4 and N_2O emission rates at or below the applicable standards or FELs must be at least one percent of your actual (not projected) U.S.-directed production volume for the engine family. Identify configurations within the family that have emission rates at or below the FCL and meet the one percent requirement. For example, if your U.S.-directed production volume for the engine family is 10,583 and the U.S.-directed production volume for the tested rating is 75 engines, then you can comply with this provision by setting your FCL so that one more rating with a U.S.-directed production volume of at least 31 engines meets the FCL. Where applicable, also identify other testable configurations required under § 1036.230(b)(2).

(f) Identify the engine family's deterioration factors and describe how you developed them (see § 1036.241). Present any test data you used for this.

(g) Present emission data to show that you meet emission standards, as follows:

(1) Present exhaust emission data for CO_2, CH_4, and N_2O on an emission-data engine to show that your engines meet the applicable emission standards we specify in § 1036.108. Show emission figures before and after applying deterioration factors for each engine. In addition to the composite results, show individual measurements for cold-start testing and hot-start testing over the transient test cycle.

(2) Note that § 1036.235 allows you to submit an application in certain cases without new emission data.

(h) State whether your certification is limited for certain engines. For example, if you certify heavy heavy-duty engines to the CO_2 standards using only transient testing, the engines may be installed only in vocational vehicles.

(i) Unconditionally certify that all the engines in the engine family comply with the requirements of this part, other referenced parts of the CFR, and the Clean Air Act. Note that § 1036.235 specifies which engines to test to show that engines in the entire family comply with the requirements of this part.

(j) Include the information required by other subparts of this part. For example, include the information required by § 1036.725 if you participate in the ABT program.

(k) Include the warranty statement and maintenance instructions if we request them.

(l) Include other applicable information, such as information specified in this part or 40 CFR part 1068 related to requests for exemptions.

(m) For imported engines or equipment, identify the following:

(1) Describe your normal practice for importing engines. For example, this may include identifying the names and addresses of any agents you have authorized to import your engines. Engines imported by nonauthorized agents are not covered by your certificate.

(2) The location of a test facility in the United States where you can test your engines if we select them for testing under a selective enforcement audit, as specified in 40 CFR part 1068, subpart E.

(n) Include information needed to certify vehicles to GHG standards under 40 CFR part 1037, as follows:

(1) Identify the engine parameters used for GEM modeling as described in 40 CFR 1037.520.

(2) Report the measured fuel consumption rate and NO_X emission level corresponding to each point of the fuel map and at each measured idle point as described in § 1036.535.

(3) State whether your application is intended to cover engine emissions measured during powertrain testing under 40 CFR 1037.550; include any associated test results and powertrain information. You may omit the fuel map specified in paragraph (n)(2) of this section (but not the idle points) if you certify the powertrain test results. If you omit the fuel map data, you will be deemed to not be certifying a fuel map.

§ 1036.210 Preliminary approval before certification.

If you send us information before you finish the application, we may review it and make any appropriate determinations, especially for questions related to engine family definitions, auxiliary emission control devices, adjustable parameters, deterioration factors, testing for service accumulation, and maintenance. Decisions made under this section are considered to be preliminary approval, subject to final review and approval. We will generally not reverse a decision where we have given you preliminary approval, unless we find new information supporting a different decision. If you request preliminary approval related to the upcoming model year or the model year after that, we will make best-efforts to make the appropriate determinations as soon as practicable. We will generally not provide preliminary approval related to a future model year more than two years ahead of time.

§ 1036.225 Amending my application for certification.

Before we issue you a certificate of conformity, you may amend your application to include new or modified engine configurations, subject to the provisions of this section. After we have issued your certificate of conformity, but before the end of the model year, you may send us an amended application requesting that we include new or modified engine configurations within the scope of the certificate, subject to the provisions of this section. You must amend your application if any changes occur with respect to any information that is included or should be included in your application.

(a) You must amend your application before you take any of the following actions:

(1) Add an engine configuration to an engine family. In this case, the engine configuration added must be consistent with other engine configurations in the engine family with respect to the criteria listed in § 1036.230.

(2) Change an engine configuration already included in an engine family in a way that may affect emissions, or change any of the components you described in your application for certification. This includes production and design changes that may affect emissions any time during the engine's lifetime.

(3) Modify an FEL and FCL for an engine family as described in paragraph (f) of this section.

(b) To amend your application for certification, send the relevant information to the Designated Compliance Officer.

(1) Describe in detail the addition or change in the engine model or configuration you intend to make.

(2) Include engineering evaluations or data showing that the amended engine family complies with all applicable requirements. You may do this by showing that the original emission-data engine is still appropriate for showing that the amended family complies with all applicable requirements.

(3) If the original emission-data engine for the engine family is not appropriate to show compliance for the new or modified engine configuration, include new test data showing that the new or modified engine configuration meets the requirements of this part.

(4) Include any other information needed to make your application correct and complete.

(c) We may ask for more test data or engineering evaluations. You must give us these within 30 days after we request them.

(d) For engine families already covered by a certificate of conformity, we will determine whether the existing certificate of conformity covers your newly added or modified engine. You may ask for a hearing if we deny your request (see § 1036.820).

(e) For engine families already covered by a certificate of conformity, you may start producing the new or modified engine configuration any time after you send us your amended application and before we make a decision under paragraph (d) of this section. However, if we determine that the affected engines do not meet applicable requirements, we will notify you to cease production of the engines and may require you to recall the engines at no expense to the owner. Choosing to produce engines under this paragraph (e) is deemed to be consent to recall all engines that we determine do not meet applicable emission standards or other requirements and to remedy the nonconformity at no expense to the owner. If you do not provide information required under paragraph (c) of this section within 30 days after we request it, you must stop producing the new or modified engines.

(f) You may ask us to approve a change to your FEL in certain cases after the start of production, but before the end of the model year. If you change an FEL for CO_2, your FCL for CO_2 is automatically set to your new FEL divided by 1.03. The changed FEL may not apply to engines you have already introduced into U.S. commerce, except as described in this paragraph (f). You may ask us to approve a change to your FEL in the following cases:

(1) You may ask to raise your FEL for your engine family at any time. In your request, you must show that you will still be able to meet the emission standards as specified in subparts B and H of this part. Use the appropriate FELs/FCLs with corresponding production volumes to calculate emission credits for the model year, as described in subpart H of this part.

(2) You may ask to lower the FEL for your engine family only if you have test data from production engines showing that emissions are below the proposed lower FEL (or below the proposed FCL for CO_2). The lower FEL/FCL applies only to engines you produce after we approve the new FEL/FCL. Use the appropriate FELs/FCLs with corresponding production volumes to calculate emission credits for the model year, as described in subpart H of this part.

§ 1036.230 Selecting engine families.

See 40 CFR 86.001–24 for instructions on how to divide your product line into families of engines that are expected to have similar emission characteristics throughout the useful life. You must certify your engines to the standards of § 1036.108 using the same engine families you use for criteria pollutants under 40 CFR part 86. The following provisions also apply:

(a) Engines certified as hybrid engines may not be included in an engine family with engines with conventional powertrains. Note that this does not prevent you from including engines in a conventional family if they are used in hybrid vehicles, as long as you certify them conventionally.

(b) If you certify engines in the family for use as both vocational and tractor engines, you must split your family into two separate subfamilies. Indicate in the application for certification that the engine family is to be split.

(1) Calculate emission credits relative to the vocational engine standard for the number of engines sold into vocational applications and relative to the tractor engine standard for the number of engines sold into non-vocational tractor applications. You may assign the numbers and configurations of engines within the respective subfamilies at any time before submitting the final report required by § 1036.730. If the family participates in averaging, banking, or trading, you must identify the type of vehicle in which each engine is installed; we may alternatively allow you to use statistical methods to determine this for a fraction of your engines. Keep records to document this determination.

(2) If you restrict use of the test configuration for your split family to only tractors, or only vocational vehicles, you must identify a second testable configuration for the other type of vehicle (or an unrestricted configuration). Identify this configuration in your application for certification. The FCL for the engine family applies for this configuration as well as the primary test configuration.

(c) If you certify in separate engine families engines that could have been certified in vocational and tractor engine subfamilies in the same engine family, count the two families as one family for purposes of determining your obligations with respect to the OBD requirements and in-use testing requirements of 40 CFR part 86. Indicate in the applications for certification that the two engine families are covered by this paragraph (c).

(d) Engine configurations within an engine family must use equivalent greenhouse gas emission controls. Unless we approve it, you may not produce nontested configurations without the same emission control hardware included on the tested configuration. We will only approve it if you demonstrate that the exclusion of the hardware does not increase greenhouse gas emissions.

§ 1036.235 Testing requirements for certification.

This section describes the emission testing you must perform to show compliance with the greenhouse gas emission standards in § 1036.108.

(a) Select a single emission-data engine from each engine family as specified in 40 CFR part 86. The standards of this part apply only with respect to emissions measured from this tested configuration and other configurations identified in § 1036.205(e). Note that configurations identified in § 1036.205(e) are considered to be ''tested configurations'' whether or not you actually tested them for certification. However, you must apply the same (or equivalent) emission controls to all other engine configurations in the engine family.

(b) Test your emission-data engines using the procedures and equipment specified in subpart F of this part. In the case of dual-fuel and flexible-fuel engines, measure emissions when operating with each type of fuel for which you intend to certify the engine. (**Note:** Measurement of criteria emissions from flexible-fuel engines generally involves operation with the fuel mixture that best represents in-use operation, or with the fuel mixture with the highest emissions.) Measure CO_2, CH_4, and N_2O emissions using the specified duty cycle(s), including cold-start and hot-start testing as specified in 40 CFR part 86, subpart N. The following provisions apply regarding test cycles for demonstrating compliance with tractor and vocational standards:

(1) If you are certifying the engine for use in tractors, you must measure CO_2 emissions using the ramped-modal cycle and measure CH_4, and N_2O emissions using the specified transient cycle.

(2) If you are certifying the engine for use in vocational applications, you must measure CO_2, CH_4, and N_2O emissions using the specified transient duty cycle, including cold-start and hot-start testing as specified in 40 CFR part 86, subpart N.

(3) You may certify your engine family for both tractor and vocational use by submitting CO_2 emission data from both ramped-modal and transient cycle testing and specifying FCLs for both.

(4) Engines certified for use in tractors may also be used in vocational vehicles; however, you may not knowingly circumvent the intent of this part (to reduce in-use emissions of CO_2) by certifying engines designed for vocational vehicles (and rarely used in tractors) to the ramped-modal cycle and not the transient cycle. For example, we would generally not allow you to certify all your engines to the ramped-modal cycle without certifying any to the transient cycle.

(c) We may measure emissions from any of your emission-data engines.

(1) We may decide to do the testing at your plant or any other facility. If we

do this, you must deliver the engine to a test facility we designate. The engine you provide must include appropriate manifolds, aftertreatment devices, electronic control units, and other emission-related components not normally attached directly to the engine block. If we do the testing at your plant, you must schedule it as soon as possible and make available the instruments, personnel, and equipment we need.

(2) If we measure emissions on your engine, the results of that testing become the official emission results for the engine. Unless we later invalidate these data, we may decide not to consider your data in determining if your engine family meets applicable requirements. This applies equally to testing for fuel maps under § 1036.535 and to engine-based powertrain testing under § 1036.630 and 40 CFR 1037.550, except that the results of our testing at individual test points do not become the official emission result if they are lower than your declared values.

(3) Before we test one of your engines, we may set its adjustable parameters to any point within the physically adjustable ranges.

(4) Before we test one of your engines, we may calibrate it within normal production tolerances for anything we do not consider an adjustable parameter. For example, this would apply for an engine parameter that is subject to production variability because it is adjustable during production, but is not considered an adjustable parameter (as defined in § 1036.801) because it is permanently sealed. For parameters that relate to a level of performance that is itself subject to a specified range (such as maximum power output), we will generally perform any calibration under this paragraph (c)(4) in a way that keeps performance within the specified range.

(d) You may ask to use carryover emission data from a previous model year instead of doing new tests, but only if all the following are true:

(1) The engine family from the previous model year differs from the current engine family only with respect to model year, items identified in § 1036.225(a), or other characteristics unrelated to emissions. We may waive this criterion for differences we determine not to be relevant.

(2) The emission-data engine from the previous model year remains the appropriate emission-data engine under paragraph (b) of this section.

(3) The data show that the emission-data engine would meet all the requirements that apply to the engine family covered by the application for certification.

(e) We may require you to test a second engine of the same configuration in addition to the engine tested under paragraph (a) of this section.

(f) If you use an alternate test procedure under 40 CFR 1065.10 and later testing shows that such testing does not produce results that are equivalent to the procedures specified in subpart F of this part, we may reject data you generated using the alternate procedure.

§ 1036.241 Demonstrating compliance with greenhouse gas emission standards.

(a) For purposes of certification, your engine family is considered in compliance with the emission standards in § 1036.108 if all emission-data engines representing the tested configuration of that engine family have test results showing official emission results and deteriorated emission levels at or below the standards. Note that your FCLs are considered to be the applicable emission standards with which you must comply for certification.

(b) Your engine family is deemed not to comply if any emission-data engine representing the tested configuration of that engine family has test results showing an official emission result or a deteriorated emission level for any pollutant that is above an applicable emission standard (generally the FCL). Note that you may increase your FCL if any certification test results exceed your initial FCL.

(c) Apply deterioration factors to the measured emission levels for each pollutant to show compliance with the applicable emission standards. Your deterioration factors must take into account any available data from in-use testing with similar engines. Apply deterioration factors as follows:

(1) *Additive deterioration factor for greenhouse gas emissions.* Except as specified in paragraphs (c)(2) and (3) of this section, use an additive deterioration factor for exhaust emissions. An additive deterioration factor is the difference between the highest exhaust emissions (typically at the end of the useful life) and exhaust emissions at the low-hour test point. In these cases, adjust the official emission results for each tested engine at the selected test point by adding the factor to the measured emissions. If the factor is less than zero, use zero. Additive deterioration factors must be specified to one more decimal place than the applicable standard.

(2) *Multiplicative deterioration factor for greenhouse gas emissions.* Use a multiplicative deterioration factor for a pollutant if good engineering judgment calls for the deterioration factor for that pollutant to be the ratio of the highest exhaust emissions (typically at the end of the useful life) to exhaust emissions at the low-hour test point. Adjust the official emission results for each tested engine at the selected test point by multiplying the measured emissions by the deterioration factor. If the factor is less than one, use one. A multiplicative deterioration factor may not be appropriate in cases where testing variability is significantly greater than engine-to-engine variability. Multiplicative deterioration factors must be specified to one more significant figure than the applicable standard.

(3) *Sawtooth deterioration patterns.* The deterioration factors described in paragraphs (c)(1) and (2) of this section assume that the highest useful life emissions occur either at the end of useful life or at the low-hour test point. The provisions of this paragraph (c)(3) apply where good engineering judgment indicates that the highest useful life emissions will occur between these two points. For example, emissions may increase with service accumulation until a certain maintenance step is performed, then return to the low-hour emission levels and begin increasing again. Such a pattern may occur with battery-based electric hybrid engines. Base deterioration factors for engines with such emission patterns on the difference between (or ratio of) the point of the sawtooth at which the highest emissions occur and the low-hour test point. Note that this applies for maintenance-related deterioration only where we allow such critical emission-related maintenance.

(4) [Reserved]

(5) *Dual-fuel and flexible-fuel engines.* In the case of dual-fuel and flexible-fuel engines, apply deterioration factors separately for each fuel type by measuring emissions with each fuel type at each test point. You may accumulate service hours on a single emission-data engine using the type of fuel or the fuel mixture expected to have the highest combustion and exhaust temperatures; you may ask us to approve a different fuel mixture if you demonstrate that a different criterion is more appropriate.

(d) Calculate emission data using measurements to at least one more decimal place than the applicable standard. Apply the deterioration factor to the official emission result, as described in paragraph (c) of this section, then round the adjusted figure to the same number of decimal places as the emission standard. Compare the rounded emission levels to the emission standard for each emission-data engine.

(e) If you identify more than one configuration in § 1036.205(e), we may test (or require you to test) any of the identified configurations. We may also require you to provide an engineering analysis that demonstrates that untested configurations listed in § 1036.205(e) comply with their FCL.

§ 1036.250 Reporting and recordkeeping for certification.

(a) Within 90 days after the end of the model year, send the Designated Compliance Officer a report including the total U.S.-directed production volume of engines you produced in each engine family during the model year (based on information available at the time of the report). Report the production by serial number and engine configuration. Small manufacturers may omit this requirement. You may combine this report with reports required under subpart H of this part.

(b) Organize and maintain the following records:

(1) A copy of all applications and any summary information you send us.

(2) Any of the information we specify in § 1036.205 that you were not required to include in your application.

(c) Keep routine data from emission tests required by this part (such as test cell temperatures and relative humidity readings) for one year after we issue the associated certificate of conformity. Keep all other information specified in this section for eight years after we issue your certificate.

(d) Store these records in any format and on any media, as long as you can promptly send us organized, written records in English if we ask for them. You must keep these records readily available. We may review them at any time.

§ 1036.255 What decisions may EPA make regarding my certificate of conformity?

(a) If we determine your application is complete and shows that the engine family meets all the requirements of this part and the Act, we will issue a certificate of conformity for your engine family for that model year. We may make the approval subject to additional conditions.

(b) We may deny your application for certification if we determine that your engine family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny your application, we will explain why in writing.

(c) In addition, we may deny your application or suspend or revoke your certificate if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.

(2) Submit false or incomplete information (paragraph (e) of this section applies if this is fraudulent). This includes doing anything after submission of your application to render any of the submitted information false or incomplete.

(3) Render inaccurate any test data.

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

(5) Produce engines for importation into the United States at a location where local law prohibits us from carrying out authorized activities.

(6) Fail to supply requested information or amend your application to include all engines being produced.

(7) Take any action that otherwise circumvents the intent of the Act or this part, with respect to your engine family.

(d) We may void the certificate of conformity for an engine family if you fail to keep records, send reports, or give us information as required under this part or the Act. Note that these are also violations of 40 CFR 1068.101(a)(2).

(e) We may void your certificate if we find that you intentionally submitted false or incomplete information. This includes rendering submitted information false or incomplete after submission.

(f) If we deny your application or suspend, revoke, or void your certificate, you may ask for a hearing (see § 1036.820).

Subpart D—Testing Production Engines

§ 1036.301 Measurements related to GEM inputs in a selective enforcement audit.

(a) Selective enforcement audits apply for engines as specified in 40 CFR part 1068, subpart E. This section describes how this applies uniquely in certain circumstances.

(b) Selective enforcement audit provisions apply with respect to your fuel maps as follows:

(1) A selective enforcement audit for fuel maps would consist of performing measurements with production engines to determine the fuel-consumption rates at each of the specified points under the engine map as declared for GEM simulations, and running GEM over one or more applicable duty cycles based on those measured values, using GEM inputs that represent any applicable vehicle configuration for which the engine is being used. The engine is considered passing for a given configuration if the new modeled emission result for every applicable duty cycle is at or below the modeled emission result corresponding to the declared GEM inputs.

(2) We may specify up to ten unique vehicle configurations for an audit to verify that an engine's fuel map is part of a complying certified engine configuration. If the audit includes fuel-map testing in conjunction with engine testing relative to exhaust emission standards, the fuel-map simulations for the whole set of vehicles and duty cycles counts as a single test result for purposes of evaluating whether the engine family meets the pass-fail criteria under 40 CFR 1068.420. If the audit includes only fuel-map testing, the fuel-map simulation for each vehicle configuration counts as a separate test for the engine.

(c) If your certification includes powertrain testing as specified in 40 CFR 1036.630, the selective enforcement audit provisions apply with respect to powertrain test results as specified in 40 CFR 1037.301 and 1037.550. We may allow manufacturers to instead perform the engine-based testing to simulate the powertrain test as specified in 40 CFR 1037.551.

(d) We may suspend or revoke certificates, based on the outcome of a selective enforcement audit, for any appropriate configurations within one or more engine families.

Subpart E—In-Use Testing

§ 1036.401 In-use testing.

We may perform in-use testing of any engine family subject to the standards of this part, consistent with the Clean Air Act and the provisions of § 1036.235. Note that this provision does not affect your obligation to test your in-use engines as described in 40 CFR part 86, subpart T.

Subpart F—Test Procedures

§ 1036.501 How do I run a valid emission test?

(a) Use the equipment and procedures specified in 40 CFR 86.1305 to determine whether engines meet the emission standards in § 1036.108. These same procedures apply for determining engine fuel maps and fuel consumption at idle as specified in § 1036.535. These procedures also apply for engine-based measurement procedures to simulate powertrain testing as specified in 40 CFR 1037.551.

(b) You may use special or alternate procedures to the extent we allow them under 40 CFR 1065.10.

(c) This subpart is addressed to you as a manufacturer, but it applies equally to anyone who does testing for you, and to us when we perform testing to determine if your engines meet emission standards.

(d) For engines that use aftertreatment technology with infrequent regeneration events, apply infrequent regeneration adjustment factors as described in § 1036.530.

(e) Test hybrid engines as described in § 1036.525 and 40 CFR part 1065.

(f) Determine engine fuel maps and fuel consumption at idle as described in § 1036.535.

(g) The following additional provisions apply for testing to demonstrate compliance with the emission standards in § 1036.108 for model year 2021 and later engines:

(1) When calculating total engine work, exclude work during any portion of the duty cycle that has a zero reference value for normalized torque.

(2) If your engine is intended for installation in a vehicle equipped with stop-start technology, you may use good engineering judgment to turn the engine off during the idle portions of the duty cycle to represent in-use operation, consistent with good engineering judgment.

(3) Use continuous sampling (not batch sampling) to measure CO_2 emissions over the ramped-modal cycle specified in 40 CFR 86.1362. Integrate the test results by mode to establish separate emission rates for each mode (including the transition following each mode, as applicable). Apply the weighting factors specified in 40 CFR 86.1362 to calculate a composite emission result.

§ 1036.525 Hybrid engines.

(a) If your engine system includes features that recover and store energy during engine motoring operation, test the engine as described in paragraph (d) of this section. For purposes of this section, features that recover energy between the engine and transmission are considered related to engine motoring.

(b) If you produce a hybrid engine designed with power take-off capability and sell the engine coupled with a transmission, you may calculate a reduction in CO_2 emissions resulting from the power take-off operation as described in 40 CFR 1037.525. Use good engineering judgment to use the vehicle-based procedures to quantify the CO_2 reduction for your engines.

(c) The hardware that must be included in these tests is the engine, the hybrid electric motor, the rechargeable energy storage system (RESS) and the power electronics between the hybrid electric motor and the RESS. You may ask us to modify the provisions of this section to allow testing non-electric hybrid vehicles, consistent with good engineering judgment.

(d) Measure emissions using the same procedures that apply for testing non-hybrid engines under this part, except as specified otherwise in this part and/or 40 CFR part 1065. If you test hybrid engines using the ramped-modal cycle, deactivate the hybrid features unless we have specified otherwise. The five differences that apply under this section are related to engine mapping, engine shutdown during the test cycle, calculating work, limits on braking energy, and state of charge constraints.

(1) Map the engine as specified in 40 CFR 1065.510. This requires separate torque maps for the engine with and without the hybrid features active. For transient testing, denormalize the test cycle using the map generated with the hybrid feature active. For steady-state testing, denormalize the test cycle using the map generated with the hybrid feature inactive.

(2) If the engine will be configured in actual use to shut down automatically during idle operation, you may let the engine shut down during the idle portions of the test cycle.

(3) Follow 40 CFR 1065.650(d) to calculate the work done over the cycle except as specified in this paragraph (d)(3). For the positive work over the cycle, set negative hybrid power to zero. For the negative work over the cycle set the positive power to zero and the set the non-hybrid power to zero.

(4) Calculate brake energy fraction, x_b, as follows:

(i) Calculate x_b as the integrated negative work over the cycle divided by the integrated positive work over the cycle according to Equation 1036.525–1. Calculate the brake energy limit for the engine, x_{bl}, according to Equation 1036.525–2. If x_b is less than x_{bl}, use the integrated positive work for your emission calculations. If x_b is greater than x_{bl} use Equation 1036.525–3 to calculate the positive work done over the cycle. Use W_{cycle} as the integrated positive work when calculating brake-specific emissions. To avoid the need to delete extra brake work from positive work you may set an instantaneous brake target that will prevent x_b from being larger than x_{bl}.

$$x_b = \left|\frac{W_{neg}}{W_{pos}}\right| \qquad \text{Eq. 1036.525-1}$$

$$x_{bl} = 4.158 \cdot 10^{-4} \cdot P_{max} + 0.2247 \qquad \text{Eq. 1036.525-2}$$

$$W_{cycle} = W_{pos} - \left(\left|W_{neg}\right| - x_{bl} \cdot W_{pos}\right) \qquad \text{Eq. 1036.525-3}$$

(ii) The following definitions apply for this paragraph (d)(4):

x_b = the brake energy fraction.
W_{neg} = the negative work over the cycle.
W_{pos} = the positive work over the cycle.
x_{bl} = the brake energy fraction limit.
P_{max} = the maximum power of the engine with the hybrid system engaged (kW).
W_{cycle} = the work over the cycle when x_b is greater than x_{bl}.

(iii) Note that these calculations are specified with SI units (such as kW), consistent with 40 CFR part 1065. Emission results are converted to g/hp-hr at the end of the calculations.

(5) Correct for the net energy change of the energy storage device as described in 40 CFR 1066.501.

§ 1036.530 Calculating greenhouse gas emission rates.

This section describes how to calculate official emission results for CO_2, CH_4, and N_2O.

(a) Calculate brake-specific emission rates for each applicable duty cycle as specified in 40 CFR 1065.650. Apply infrequent regeneration adjustment factors to your cycle-average results as described in 40 CFR 86.004–28 for CO_2 starting in model year 2021. You may optionally apply infrequent regeneration adjustment factors for CH_4 and N_2O.

(b) Adjust CO_2 emission rates calculated under paragraph (a) of this section for measured test fuel properties as specified in this paragraph (b) to obtain the official emission results. You are not required to apply this adjustment for fuels containing at least 75 percent pure alcohol, such as E85. The purpose of this adjustment is to make official emission results independent of differences in test fuels within a fuel type. Use good engineering judgment to develop and apply testing protocols to minimize the impact of variations in test fuels.

(1) Determine mass-specific net energy content, $E_{\text{mfuelmeas}}$, also known as lower heating value, in MJ/kg, expressed to at least three decimal places, as follows:

(i) For liquid fuels, determine $E_{\text{mfuelmeas}}$ according to ASTM D4809 (recommended) or ASTM D240 (both incorporated by reference in § 1036.810).

(ii) For gaseous fuels, determine $E_{\text{mfuelmeas}}$ using good engineering judgment.

(iii) If you determine based on good engineering judgment that your careful control of test fuel properties causes variations in the actual mass-specific energy content and carbon mass fraction to be the same as or smaller than the repeatability of measuring those values, you may use constant values equal to the average values for your test fuel. If you use a constant value, you must update or verify the value at least once per year, or after changes in test fuel suppliers or specifications.

(2) Determine your test fuel's carbon mass fraction, w_C as described in 40 CFR 1065.655(d), expressed to at least three decimal places; however, you must measure fuel properties rather than using the default values specified in Table 1 of 40 CFR 1065.655.

(3) Correct measured CO_2 emission rates as follows:

$$e_{\text{CO2cor}} = e_{\text{CO2}} \cdot \frac{E_{\text{mfuelmeas}}}{E_{\text{mfuelCref}} \cdot w_{\text{Cmeas}}} \qquad \text{Eq. 1036.530-1}$$

Where:

e_{CO2} = the calculated CO_2 emission result.

$E_{\text{mfuelmeas}}$ = the mass-specific net energy content of the test fuel as determined by paragraph (b)(1) of this section.

$E_{\text{mfuelCref}}$ = the reference value of carbon-specific net energy content for the appropriate fuel, as determined in Table 1 of this section.

w_{Cmeas} = carbon mass fraction of the test fuel as determined under paragraph (b)(2) of this section.

Example:

$$e_{\text{CO2}} = 630.0 \text{ g/hp·hr}$$

$$E_{\text{mfuelmeas}} = 42.528 \text{ MJ/kg}$$

$$E_{\text{mfuelCref}} = 49.3112 \text{ MJ/kgC}$$

$$w_{\text{Cmeas}} = 0.870$$

$$e_{\text{CO2cor}} = 630.0 \cdot \frac{42.528}{49.3112 \cdot 0.870}$$

$$e_{\text{CO2cor}} = 624.5 \text{ g/hp·hr}$$

TABLE 1 OF § 1036.530—REFERENCE FUEL PROPERTIES

Fuel Type[a]	Reference fuel carbon-mass-specific net energy content, $E_{\text{mfuelCref}}$, (MJ/kgC)	Reference fuel carbon mass fraction, w_{Cref}
Diesel fuel	49.3112	0.874
Gasoline	50.4742	0.846
Natural Gas	66.2910	0.750
LPG	56.5218	0.820
Dimethyl Ether	55.3886	0.521

[a] For fuels that are not listed, you must ask us to approve a reference fuel and its properties.

(c) Your official CO_2 emission result equals your calculated brake-specific emission rate multiplied by all applicable adjustment factors, other than the deterioration factor.

§ 1036.535 Determining engine fuel maps and fuel consumption at idle.

This section describes procedures for determining an engine's fuel-consumption rate for model year 2021 and later vehicles. Note that vehicle manufacturers will generally use these values to demonstrate compliance with vehicle-based Phase 2 emission standards that rely on emission modeling using the GEM simulation tool, as described in 40 CFR 1037.510.

(a) *General test provisions.* Perform fuel mapping using the procedure described in paragraph (b) of this section to establish measured fuel-consumption rates at a range of engine speed and load settings. Measure fuel consumption at idle using the procedure described in paragraph (c) of this section. Use these measured fuel-consumption values to declare fuel-consumption rates for certification as described in paragraph (d) of this section. Also measure NO_X emissions (in g/s) during each of the specified sampling periods consistent with the data requirements 40 CFR part 86, subpart T. Perform emission measurements as described in 40 CFR 1065.530 for discrete-mode steady-state testing. Control engine speed and torque to within ±20 rpm and ±20 N·m, or 20 percent of the speed and torque setpoint, whichever is greater. This section uses engine parameters and variables that are consistent with 40 CFR part 1065. For molar mass values, see 40 CFR 1065.1005.

(b) *Steady-state fuel mapping.* Determine fuel-consumption rates for each engine configuration over a series of steady-state engine operating points as described in this paragraph (b). You may use shared data across an engine platform to the extent that the fuel-consumption rates remain valid. For example, if you test a high-output configuration and create a different configuration that uses the same fueling strategy but limits the engine operation to be a subset of that from the high-output configuration, you may use the fuel-consumption rates for the reduced number of mapped points for the low-output configuration, as long as the narrower map includes at least 100 points. Perform fuel mapping as follows:

(1) Select 13 speed points that include warm idle speed, f_{nidle}, the highest speed above maximum power at which 70% of

maximum power occurs, $n_{hi,}$ and 11 equally spaced points between f_{nidle} and $n_{hi.}$ If operating the engine at the specified speeds causes unstable engine operation due to operating on the low or high speed governor you may adjust the speed setpoint for those points as needed. Typically this would only happen at f_{nidle} above zero torque and n_{hi} at 100% torque. f_{nidle} and zero torque must be one of the test points.

(2) Select 11 normalized torque values at each of the speed points determined in paragraph (b)(1) of this section, including $T = 0$, maximum mapped torque, $T_{max\ mapped,}$ and 9 equally spaced points between $T = 0$ and $T_{max\ mapped.}$ Normalized torque values are expressed as a percentage of $T_{max\ mapped}$ at a given engine speed.

(3) Warm up the engine as described in 40 CFR 1065.510(b)(2).

(4) Within 60 seconds after concluding the warm-up procedure, operate the engine at f_{ntest} and the highest torque value, $T_{max,}$ at that speed.

(5) After the engine operates at the set speed and torque for 60 seconds, start recording measurements using one of the following methods:

(i) *Carbon mass balance.* Record speed and torque and measure emissions of CO_2, CO, NMHC, and CH_4 for (29 to 31) seconds and determine the corresponding mean values for the sampling period.

(ii) *Direct measurement of fuel flow.* Record speed and torque and measure fuel consumption with a fuel flow meter for (29 to 31) seconds and determine the corresponding mean values for the sampling period.

(6) Within 15 seconds after completing the sampling period described in paragraph (b)(5) of this section, set the engine to operate at the next lowest torque value while holding speed constant. Perform the measurements described at the new torque setting and repeat this sequence for all remaining torque values down to $T = 0$.

(7) Continue testing to complete fuel mapping as follows:

(i) Within 15 seconds after sampling at $T = 0$, set the engine to operate at the next lowest speed value and increase torque to $T_{max.}$ Perform measurements for all the torque values at the selected speed as described in paragraphs (b)(5) and (6) of this section. Repeat this sequence for all remaining speed values down to f_{nidle} to complete the fuel-mapping procedure. You may interrupt the mapping sequence to calibrate emission-measurement instrumentation only during stabilization at T_{max} for a given speed.

(ii) If an infrequent regeneration event occurs during fuel mapping, invalidate all the measurements made at that engine speed. Allow the regeneration event to finish, then restart engine stabilization at T_{max} at the same engine speed and continue with measurements from that point in the fuel-mapping sequence.

(8) If you determine fuel-consumption rates using emission measurements from the raw or diluted exhaust, calculate the mean fuel mass flow rate,, for each point in the fuel map using the following equation:

$$\bar{\dot{m}}_{fuel} = \frac{M_C}{w_{Cmeas}} \cdot \left(\bar{\dot{n}}_{exh} \cdot \frac{\bar{x}_{Ccombdry}}{1 + \bar{x}_{H2Oexhdry}} - \frac{\bar{\dot{m}}_{CO2urea}}{M_{CO2}} \right) \quad \text{Eq. 1036.535-1}$$

Where:

m_{fuel} = mean fuel mass flow rate for a given fuel map setpoint, expressed to at least the nearest 0.001 g/s.

M_C = molar mass of carbon.

w_{Cmeas} = carbon mass fraction of fuel as determined by 40 CFR 1065.655(d), except that you may not use the default properties in Table 1 of 40 CFR 1065.655 to determine α, β, and w_C for liquid fuels.

n_{exh} = the mean raw exhaust molar flow rate from which you measured emissions according to 40 CFR 1065.655.

$x_{Ccombdry}$ = the mean concentration of carbon from fuel in the exhaust per mole of dry exhaust.

$\bar{x}_{H2Oexhdry}$ = the mean concentration of H_2O in exhaust per mole of dry exhaust.

$\bar{\dot{m}}_{CO2urea}$ = the mean CO_2 mass emission rate from urea decomposition as described in paragraph (b)(9) of this section. If your engine does not utilize urea SCR for emission control, or if you choose not to perform this correction, set $\bar{\dot{m}}_{CO2urea}$ equal to 0.

M_{CO2} = molar mass of carbon dioxide.

Example:

$$\bar{\dot{m}}_{fuel} = \frac{12.0107}{0.869} \cdot \left(25.534 \cdot \frac{0.002805}{1 + 0.0353} - \frac{0.0726}{44.0095} \right) = 0.933 \text{ g/s}$$

(9) If you determine fuel-consumption rates using emission measurements with engines that have urea SCR for NO_X control, you may correct for the mean CO_2 emissions coming from urea decomposition, $\bar{\dot{m}}_{CO2urea}$, at each fuel map setpoint using the following equation:

$$\bar{\dot{m}}_{CO2urea} = \bar{\dot{m}}_{urea} \cdot \frac{M_{CO2} \cdot MF_{CH4N2O}}{M_{CH4N2O}} \quad \text{Eq. 1036.535-2}$$

Where:

$\bar{\dot{m}}_{urea}$ = the mean mass flow rate of injected urea solution for a given sampling period.

M_{CO2} = molar mass of carbon dioxide.

MF_{CH4N2O} = mass fraction of urea in aqueous solution. Note that the subscript ''CH_4N_2O'' refers to urea as a pure compound and the subscript ''urea'' refers to the aqueous urea solution.

M_{CH4N2O} = molar mass of urea.

Example:

$\bar{\dot{m}}_{urea}$= 0. 304 g/s

M_{CO2} = 44.0095 g/mol

MF_{CH4N2O} = 32.5% = 0.325

M_{CH4N2O} = 60.05526 g/mol

$$\bar{\dot{m}}_{\text{CO2urea}} = 0.304 \cdot \frac{44.0095 \cdot 0.325}{60.05526} = 0.0726 \text{ g/s}$$

(10) For all fuels except those that have at least 75% pure alcohol, correct the measured or calculated mean fuel mass flow rate, $\bar{\dot{m}}_{\text{fuel}}$ at each engine operating condition to a mass-specific net energy content of a reference fuel using the following equation and the values specified in Table 1 of § 1036.530:

$$\bar{\dot{m}}_{\text{fuelcor}} = \bar{\dot{m}}_{\text{fuel}} \cdot \frac{E_{\text{mfuelmeas}} \cdot w_{\text{Cref}}}{E_{\text{mfuelCref}}} \qquad \text{Eq. 1036.535-3}$$

Example:

$\bar{\dot{m}}_{\text{fuel}}$ = 0.933 g/s

$E_{\text{mfuelmeas}}$ = 42.7984 MJ/kgC

w_{Cref} = 0.874

$E_{\text{mfuelCref}}$ = 49.3112 MJ/kgC

$$\bar{\dot{m}}_{\text{fuel}} = 0.933 \cdot \frac{42.7984 \cdot 0.874}{49.3112} = 0.708 \text{ g/s}$$

(c) *Fuel consumption at idle.* Determine values for fuel-consumption rate at idle for each engine configuration as described in this paragraph (c). You may use shared data across engine configurations, consistent with good engineering judgment. Perform measurements as follows:

(1) Warm up the engine as described in 40 CFR 1065.510(b)(2).

(2) Within 60 seconds after concluding the warm-up procedure, operate the engine at its minimum declared warm idle speed, f_{nidlemin}, as described in 40 CFR 1065.510(b)(3), set zero torque, and start the sampling period. Continue sampling for (595 to 605) seconds. Perform measurements using one of the following methods during the sampling period:

(i) *Carbon mass balance.* Record speed and torque and measure emissions of CO_2, CO, NMHC, and CH_4 and determine the corresponding mean values for the sampling period. Calculate the mean fuel mass flow rate, $\bar{\dot{m}}_{\text{fuel}}$, during the sampling period as described in paragraph (b)(8) of this section.

(ii) *Direct measurement of fuel flow.* Record speed and torque and measure fuel consumption with a fuel flow meter and determine the corresponding mean values for the sampling period.

(3) Repeat the steps in paragraphs (c)(1) and (2) of this section with the engine set to operate at idle torque, T_{idle}. Determine T_{idle} using the following equation:

$$T_{\text{idle}} = \frac{T_{\text{fnstall}} \cdot f_{\text{fnidle}}^2}{f_{\text{fnstall}}^2} + \frac{P_{\text{acc}}}{f_{\text{nidle}}} \qquad \text{Eq. 1036.535-2}$$

Where:

T_{fnstall} = the maximum engine torque at f_{nstall}.

f_{nidle} = the applicable engine idle speed as described in this paragraph (c).

f_{nstall} = the stall speed of the torque converter; use f_{ntest} or 2250 rpm, whichever is lower.

P_{acc} = accessory power for the vehicle class; use 1300 W.

Example:

f_{ntest} = 1740.8 rpm = 182.30 rad/s

f_{nstall} = 1740.8 rpm = 182.30 rad/s

T_{fnstall} = 1870 N·m

P_{acc} = 1300 W

f_{nidle} = 600 rpm = 62.83 rad/s

$$T_{\text{idle}} = \frac{1870 \cdot 62.83^2}{182.30^2} + \frac{1300}{62.83} = 242.84 \text{ N} \cdot \text{m}$$

(4) Repeat the steps in paragraphs (c)(1) through (3) of this section with the engine operated at its declared maximum warm idle speed, f_{nidlemax}.

(5) If an infrequent regeneration event occurs during this procedure, invalidate any measurements made at that idle condition. Allow the regeneration event to finish, then repeat the measurement and continue with the test sequence.

(6) Correct the measured or calculated mean fuel mass flow rate, $\bar{\dot{m}}_{\text{fuel}}$ at each of the four idle settings to account for mass-specific net energy content as described in paragraph (b)(10) of this section.

(d) *Measured vs. declared fuel-consumption rates.* Select fuel-consumption rates (g/s) to characterize the engine's fuel map and fuel-consumption rate at idle. These declared values may not be lower than any corresponding measured values determined in paragraphs (b) and (c) of this section. You may select any value that is at or above the corresponding measured value. Use good engineering judgment to select values that will be at or below the fuel-consumption rates for your production engines. These declared fuel-consumption rates are the values that vehicle manufacturers will use for certification. Note that production engines are subject to GEM cycle-weighted limits as described in § 1036.301.

Subpart G—Special Compliance Provisions

§ 1036.601 What compliance provisions apply?

(a) Engine and vehicle manufacturers, as well as owners, operators, and rebuilders of engines subject to the requirements of this part, and all other persons, must observe the provisions of this part, the provisions of 40 CFR part 1068, and the provisions of the Clean Air Act. The provisions of 40 CFR part 1068 apply for heavy-duty highway engines as specified in that part, subject to the following provisions:

(1) The hardship exemption provisions of 40 CFR 1068.245, 1068.250, and 1068.255 do not apply for motor vehicle engines.

(2) The provisions of 40 CFR 1068.235 that allow for modifying certified engines for competition do not apply for heavy-duty vehicles or heavy-duty engines. Certified motor vehicles and motor vehicle engines and their emission control devices must remain in their certified configuration even if they are used solely for competition or if they become nonroad vehicles or engines; anyone modifying a certified motor vehicle or motor vehicle engine for any reason is subject to the tampering and defeat device prohibitions of 40 CFR 1068.101(b) and 42 U.S.C. 7522(a)(3). Note that a new engine that will be installed in a vehicle that will be used solely for competition may be excluded from the requirements of this part based on a determination that the vehicle is not a motor vehicle under 40 CFR 85.1703.

(3) The tampering prohibition in 40 CFR 1068.101(b)(1) applies for alternative fuel conversions as specified in 40 CFR part 85, subpart F.

(4) The warranty-related prohibitions in section 203(a)(4) of the Act (42 U.S.C. 7522(a)(4)) apply to manufacturers of new heavy-duty highway engines in addition to the prohibitions described in 40 CFR 1068.101(b)(6). We may assess a civil penalty up to $37,500 for each engine or vehicle in violation.

(b) Engines exempted from the applicable standards of 40 CFR part 86 are exempt from the standards of this part without request.

(c) The emergency vehicle field modification provisions of 40 CFR 85.1716 apply with respect to the standards of this part.

(d) Subpart C of this part describes how to test and certify dual-fuel and flexible-fuel engines. Some multi-fuel engines may not fit either of those defined terms. For such engines, we will determine whether it is most appropriate to treat them as single-fuel engines, dual-fuel engines, or flexible-fuel engines based on the range of possible and expected fuel mixtures. For example, an engine might burn natural gas but initiate combustion with a pilot injection of diesel fuel. If the engine is designed to operate with a single fueling algorithm (*i.e.,* fueling rates are fixed at a given engine speed and load condition), we would generally treat it as a single-fuel engine. In this context, the combination of diesel fuel and natural gas would be its own fuel type. If the engine is designed to also operate on diesel fuel alone, we would generally treat it as a dual-fueled engine. If the engine is designed to operate on varying mixtures of the two fuels, we would generally treat it as a flexible-fueled engine. To the extent that requirements vary for the different fuels or fuel mixtures, we may apply the more stringent requirements.

§ 1036.610 Off-cycle technology credits and adjustments for reducing greenhouse gas emissions.

(a) You may ask us to apply the provisions of this section for CO_2 emission reductions resulting from powertrain technologies that were not in common use with heavy-duty vehicles before model year 2010 that are not reflected in the specified test procedure. We will apply these provisions only for technologies that will result in a measurable, demonstrable, and verifiable real-world CO_2 reduction. Note that prior to MY 2016, these technologies were referred to as ''innovative technologies''.

(b) The provisions of this section may be applied as either an improvement factor (used to adjust emission results) or as a separate credit within the engine family, consistent with good engineering judgment. Note that the term ''credit'' in this section describes an additive adjustment to emission rates and is not equivalent to an emission credit in the ABT program of subpart H of this part. We recommend that you base your credit/adjustment on A to B testing of pairs of engines/vehicles differing only with respect to the technology in question.

(1) Calculate improvement factors as the ratio of in-use emissions with the technology divided by the in-use emissions without the technology. Adjust the emission results by multiplying by the improvement factor. Use the improvement-factor approach where good engineering judgment indicates that the actual benefit will be proportional to emissions measured over the test procedures specified in this part. For example, the benefits from technologies that reduce engine operation would generally be proportional to the engine's emission rate.

(2) Calculate separate credits based on the difference between the in-use emission rate (g/ton-mile) with the technology and the in-use emission rate without the technology. Subtract this value from your measured emission result and use this adjusted value to determine your FEL. We may also allow you to calculate the credits based on g/hp-hr emission rates. Use the separate-credit approach where good engineering judgment indicates that the actual benefit will not be proportional to emissions measured over the test procedures specified in this part.

(3) We may require you to discount or otherwise adjust your improvement factor or credit to account for uncertainty or other relevant factors.

(c) Send your request to the Designated Compliance Officer. We recommend that you do not begin collecting test data (for submission to EPA) before contacting us. For technologies for which the vehicle manufacturer could also claim credits (such as transmissions in certain circumstances), we may require you to include a letter from the vehicle manufacturer stating that it will not seek credits for the same technology. Your request must contain the following items:

(1) A detailed description of the off-cycle technology and how it functions to reduce CO_2 emissions under conditions not represented on the duty cycles required for certification.

(2) A list of the engine configurations that will be equipped with the technology.

(3) A detailed description and justification of the selected test engines.

(4) All testing and simulation data required under this section, plus any other data you have considered in your analysis. You may ask for our preliminary approval of your test plan under § 1036.210.

(5) A complete description of the methodology used to estimate the off-cycle benefit of the technology and all supporting data, including engine testing and in-use activity data. Also include a statement regarding your recommendation for applying the provisions of this section for the given technology as an improvement factor or a credit.

(6) An estimate of the off-cycle benefit by engine model, and the fleetwide benefit based on projected sales of engine models equipped with the technology.

(7) A demonstration of the in-use durability of the off-cycle technology,

based on any available engineering analysis or durability testing data (either by testing components or whole engines).

(d) We may seek public comment on your request, consistent with the provisions of 40 CFR 86.1869–12(d). However, we will generally not seek public comment on credits/adjustments based on A to B engine dynamometer testing, chassis testing, or in-use testing.

(e) We may approve an improvement factor or credit for any engine family that is properly represented by your testing. You may similarly continue to use an approved improvement factor or credit for any appropriate engine families in future model years through 2020. Starting in model year 2021, you must request our approval before applying an improvement factor or credit under this section for any kind of technology, even if we approved an improvement factor or credit for similar engine models before model year 2021.

§ 1036.615 Engines with Rankine cycle waste heat recovery and hybrid powertrains.

This section specifies how to generate advanced technology-specific emission credits for hybrid powertrains that include energy storage systems and regenerative braking (including regenerative engine braking) and for engines that include Rankine-cycle (or other bottoming cycle) exhaust energy recovery systems. This section applies only for model year 2020 and earlier engines.

(a) *Pre-transmission hybrid powertrains.* Test pre-transmission hybrid powertrains with the hybrid engine test procedures of 40 CFR part 1065 or with the post-transmission test procedures in 40 CFR 1037.550. Pre-transmission hybrid powertrains are those engine systems that include features to recover and store energy during engine motoring operation but not from the vehicle's wheels.

(b) *Rankine engines.* Test engines that include Rankine-cycle exhaust energy recovery systems according to the test procedures specified in subpart F of this part unless we approve alternate procedures.

(c) *Calculating credits.* Calculate credits as specified in subpart H of this part. Credits generated from engines and powertrains certified under this section may be used in other averaging sets as described in § 1036.740(c).

(d) *Off-cycle technologies.* You may certify using both the provisions of this section and the off-cycle technology provisions of § 1036.610, provided you do not double-count emission benefits.

§ 1036.620 Alternate CO_2 standards based on model year 2011 compression-ignition engines.

For model years 2014 through 2016, you may certify your compression-ignition engines to the CO_2 standards of this section instead of the CO_2 standards in § 1036.108. However, you may not certify engines to these alternate standards if they are part of an averaging set in which you carry a balance of banked credits. You may submit applications for certifications before using up banked credits in the averaging set, but such certificates will not become effective until you have used up (or retired) your banked credits in the averaging set. For purposes of this section, you are deemed to carry credits in an averaging set if you carry credits from advanced technology that are allowed to be used in that averaging set.

(a) The standards of this section are determined from the measured emission rate of the test engine of the applicable baseline 2011 engine family(ies) as described in paragraphs (b) and (c) of this section. Calculate the CO_2 emission rate of the baseline test engine using the same equations used for showing compliance with the otherwise applicable standard. The alternate CO_2 standard for light and medium heavy-duty vocational-certified engines (certified for CO_2 using the transient cycle) is equal to the baseline emission rate multiplied by 0.975. The alternate CO_2 standard for tractor-certified engines (certified for CO_2 using the ramped-modal cycle) and all other heavy heavy-duty engines is equal to the baseline emission rate multiplied by 0.970. The in-use FEL for these engines is equal to the alternate standard multiplied by 1.03.

(b) This paragraph (b) applies if you do not certify all your engine families in the averaging set to the alternate standards of this section. Identify separate baseline engine families for each engine family that you are certifying to the alternate standards of this section. For an engine family to be considered the baseline engine family, it must meet the following criteria:

(1) It must have been certified to all applicable emission standards in model year 2011. If the baseline engine was certified to a NO_X FEL above the standard and incorporated the same emission control technologies as the new engine family, you may adjust the baseline CO_2 emission rate to be equivalent to an engine meeting the 0.20 g/hp-hr NO_X standard (or your higher FEL as specified in this paragraph (b)(1)), using certification results from model years 2009 through 2011, consistent with good engineering judgment.

(i) Use the following equation to relate model year 2009–2011 NO_X and CO_2 emission rates (g/hp-hr): $CO_2 = a \times \log(NO_X)+b$.

(ii) For model year 2014–2016 engines certified to NO_X FELs above 0.20 g/hp-hr, correct the baseline CO_2 emissions to the actual NO_X FELs of the 2014–2016 engines.

(iii) Calculate separate adjustments for emissions over the ramped-modal cycle and the transient cycle.

(2) The baseline configuration tested for certification must have the same engine displacement as the engines in the engine family being certified to the alternate standards, and its rated power must be within five percent of the highest rated power in the engine family being certified to the alternate standards.

(3) The model year 2011 U.S.-directed production volume of the configuration tested must be at least one percent of the total 2011 U.S.-directed production volume for the engine family.

(4) The tested configuration must have cycle-weighted BSFC equivalent to or better than all other configurations in the engine family.

(c) This paragraph (c) applies if you certify all your engine families in the primary intended service class to the alternate standards of this section. For purposes of this section, you may combine light heavy-duty and medium heavy-duty engines into a single averaging set. Determine your baseline CO_2 emission rate as the production-weighted emission rate of the certified engine families you produced in the 2011 model year. If you produce engines for both tractors and vocational vehicles, treat them as separate averaging sets. Adjust the CO_2 emission rates to be equivalent to an engine meeting the average NO_X FEL of new engines (assuming engines certified to the 0.20 g/hp-hr NO_X standard have a NO_X FEL equal to 0.20 g/hp-hr), as described in paragraph (b)(1) of this section.

(d) Include the following statement on the emission control information label: ''THIS ENGINE WAS CERTIFIED TO AN ALTERNATE CO_2 STANDARD UNDER § 1036.620.''

(e) You may not bank CO_2 emission credits for any engine family in the same averaging set and model year in which you certify engines to the standards of this section. You may not bank any advanced technology credits in any averaging set for the model year you certify under this section (since such credits would be available for use in this averaging set). Note that the provisions of § 1036.745 apply for deficits generated with respect to the standards of this section.

(f) You need our approval before you may certify engines under this section, especially with respect to the numerical value of the alternate standards. We will not approve your request if we determine that you manipulated your engine families or test engine configurations to certify to less stringent standards, or that you otherwise have not acted in good faith. You must keep and provide to us any information we need to determine that your engine families meet the requirements of this section. Keep these records for at least five years after you stop producing engines certified under this section.

§ 1036.625 In-use compliance with family emission limits (FELs).

Section 1036.225 describes how to change the FEL for an engine family during the model year. This section, which describes how you may ask us to increase an engine family's FEL after the end of the model year, is intended to address circumstances in which it is in the public interest to apply a higher in-use FEL based on forfeiting an appropriate number of emission credits.

(a) You may ask us to increase an engine family's FEL after the end of the model year if you believe some of your in-use engines exceed the CO_2 FEL that applied during the model year (or the CO_2 emission standard if the family did not generate or use emission credits). We may consider any available information in making our decision to approve or deny your request.

(b) If we approve your request under this section, you must apply emission credits to cover the increased FEL for all affected engines. Apply the emission credits as part of your credit demonstration for the current production year. Include the appropriate calculations in your final report under § 1036.730.

(c) Submit your request to the Designated Compliance Officer. Include the following in your request:

(1) Identify the names of each engine family that is the subject of your request. Include separate family names for different model years

(2) Describe why your request does not apply for similar engine models or additional model years, as applicable.

(3) Identify the FEL(s) that applied during the model year and recommend a replacement FEL for in-use engines; include a supporting rationale to describe how you determined the recommended replacement FEL.

(4) Describe whether the needed emission credits will come from averaging, banking, or trading.

(d) If we approve your request, we will identify the replacement FEL. The value we select will reflect our best judgment to accurately reflect the actual in-use performance of your engines, consistent with the testing provisions specified in this part. We may apply the higher FELs to other engine families from the same or different model years to the extent they used equivalent emission controls. We may include any appropriate conditions with our approval.

(e) If we order a recall for an engine family under 40 CFR 1068.505, we will no longer approve a replacement FEL under this section for any of your engines from that engine family, or from any other engine family that relies on equivalent emission controls.

§ 1036.630 Certification of engine GHG emissions for powertrain testing.

For engines included in powertrain families under 40 CFR part 1037, you may choose to include the corresponding engine emissions in your engine families under this part 1036.

(a) If you choose to include engine emissions in an engine family, the declared powertrain emission levels become standards that apply for selective enforcement audits and in-use testing. We may require that you provide the engine test cycle (not normalized) corresponding to a given powertrain for each of the specified duty cycles.

(b) If you choose to certify only fuel map emissions for an engine family and to not certify emissions over powertrain test cycles under 40 CFR 1037.550, we will not presume you are responsible for emissions over the powertrain cycles. However, where we determine that you are responsible in whole or in part for the emission exceedance in such cases, we may require that you participate in any recall of the affected vehicles. Note that this provision does not apply if you also hold the certificate of conformity for the vehicle.

Subpart H—Averaging, Banking, and Trading for Certification

§ 1036.701 General provisions.

(a) You may average, bank, and trade (ABT) emission credits for purposes of certification as described in this subpart and in subpart B of this part to show compliance with the standards of § 1036.108. Participation in this program is voluntary. (**Note:** As described in subpart B of this part, you must assign an FCL to all engine families, whether or not they participate in the ABT provisions of this subpart.)

(b) The definitions of subpart I of this part apply to this subpart. The following definitions also apply:

(1) *Actual emission credits* means emission credits you have generated that we have verified by reviewing your final report.

(2) *Averaging set* means a set of engines in which emission credits may be exchanged. Credits generated by one engine may only be used by other engines in the same averaging set. See § 1036.740.

(3) *Broker* means any entity that facilitates a trade of emission credits between a buyer and seller.

(4) *Buyer* means the entity that receives emission credits as a result of a trade.

(5) *Reserved emission credits* means emission credits you have generated that we have not yet verified by reviewing your final report.

(6) *Seller* means the entity that provides emission credits during a trade.

(7) *Standard* means the emission standard that applies under subpart B of this part for engines not participating in the ABT program of this subpart.

(8) *Trade* means to exchange emission credits, either as a buyer or seller.

(c) Emission credits may be exchanged only within an averaging set as specified in § 1036.740.

(d) You may not use emission credits generated under this subpart to offset any emissions that exceed an FCL or standard. This applies for all testing, including certification testing, in-use testing, selective enforcement audits, and other production-line testing. However, if emissions from an engine exceed an FCL or standard (for example, during a selective enforcement audit), you may use emission credits to recertify the engine family with a higher FCL that applies only to future production.

(e) You may use either of the following approaches to retire or forego emission credits:

(1) You may retire emission credits generated from any number of your engines. This may be considered donating emission credits to the environment. Identify any such credits in the reports described in § 1036.730. Engines must comply with the applicable FELs even if you donate or sell the corresponding emission credits under this paragraph (h). Those credits may no longer be used by anyone to demonstrate compliance with any EPA emission standards.

(2) You may certify an engine family using an FEL (FCL for CO_2) below the

emission standard as described in this part and choose not to generate emission credits for that family. If you do this, you do not need to calculate emission credits for those engine families and you do not need to submit or keep the associated records described in this subpart for that family.

(f) Emission credits may be used in the model year they are generated. Surplus emission credits may be banked for future model years. Surplus emission credits may sometimes be used for past model years, as described in § 1036.745.

(g) You may increase or decrease an FCL during the model year by amending your application for certification under § 1036.225. The new FCL may apply only to engines you have not already introduced into commerce.

(h) See § 1036.740 for special credit provisions that apply for greenhouse gas credits generated under 40 CFR 86.1819–14(k)(7) or § 1036.615 or 40 CFR 1037.615.

(i) Unless the regulations explicitly allow it, you may not calculate credits more than once for any emission reduction. For example, if you generate CO_2 emission credits for a hybrid engine under this part for a given vehicle, no one may generate CO_2 emission credits for that same hybrid engine and vehicle under 40 CFR part 1037. However, credits could be generated for identical vehicles using engines that did not generate credits under this part.

(j) You may use emission credits generated in one model year without adjustment for certifying vehicles in a later model year, even if emission standards are different.

(k) Engine families you certify with a nonconformance penalty under 40 CFR part 86, subpart L, may not generate emission credits.

§ 1036.705 Generating and calculating emission credits.

(a) The provisions of this section apply separately for calculating emission credits for each pollutant.

(b) For each participating family, calculate positive or negative emission credits relative to the otherwise applicable emission standard based on the engine family's FCL for greenhouse gases. If your engine family is certified to both the vocational and tractor engine standards, calculate credits separately for the vocational engines and the tractor engines (as specified in paragraph (b)(3) of this section). Calculate positive emission credits for a family that has an FCL below the standard. Calculate negative emission credits for a family that has an FCL above the standard. Sum your positive and negative credits for the model year before rounding. Round the sum of emission credits to the nearest megagram (Mg), using consistent units throughout the following equations:

(1) For vocational engines:

$$\text{Emission credits (Mg)} = (\text{Std}-\text{FCL}) \cdot (\text{CF}) \cdot (\text{Volume}) \cdot (\text{UL}) \cdot (10^{-6})$$

Where:

Std = the emission standard, in g/hp-hr, that applies under subpart B of this part for engines not participating in the ABT program of this subpart (the ''otherwise applicable standard'').

FCL = the Family Certification Level for the engine family, in g/hp-hr, measured over the transient duty cycle, rounded to the same number of decimal places as the emission standard.

CF = a transient cycle conversion factor (hp-hr/mile), calculated by dividing the total (integrated) horsepower-hour over the duty cycle (average of vocational engine configurations weighted by their production volumes) by 6.3 miles for spark-ignition engines and 6.5 miles for compression-ignition engines. This represents the average work performed by vocational engines in the family over the mileage represented by operation over the duty cycle.

Volume = the number of vocational engines eligible to participate in the averaging, banking, and trading program within the given engine family during the model year, as described in paragraph (c) of this section.

UL = the useful life for the given engine family, in miles.

(2) For tractor engines:

$$\text{Emission credits (Mg)} = (\text{Std}-\text{FCL}) \cdot (\text{CF}) \cdot (\text{Volume}) \cdot (\text{UL}) \cdot (10^{-6})$$

Where:

Std = the emission standard, in g/hp-hr, that applies under subpart B of this part for engines not participating in the ABT program of this subpart (the ''otherwise applicable standard'').

FCL = the Family Certification Level for the engine family, in g/hp-hr, measured over the ramped-modal cycle rounded to the same number of decimal places as the emission standard.

CF = a transient cycle conversion factor (hp-hr/mile), calculated by dividing the total (integrated) horsepower-hour over the duty cycle (average of tractor-engine configurations weighted by their production volumes) by 6.3 miles for spark-ignition engines and 6.5 miles for compression-ignition engines. This represents the average work performed by tractor engines in the family over the mileage represented by operation over the duty cycle. Note that this calculation requires you to use the transient cycle conversion factor even for engines certified to standards based on the ramped-modal cycle.

Volume = the number of tractor engines eligible to participate in the averaging, banking, and trading program within the given engine family during the model year, as described in paragraph (c) of this section.

UL = the useful life for the given engine family, in miles.

(3) For engine families certified to both the vocational and tractor engine standards, we may allow you to use statistical methods to estimate the total production volumes where a small fraction of the engines cannot be tracked precisely.

(4) You may not generate emission credits for tractor engines (*i.e.,* engines not certified to the transient cycle for CO_2) installed in vocational vehicles (including vocational tractors certified pursuant to 40 CFR 1037.630 or exempted pursuant to 40 CFR 1037.631). We will waive this requirement where you demonstrate that less than five percent of the engines in your tractor family were installed in vocational vehicles. For example, if you know that 96 percent of your tractor engines were installed in non-vocational tractors, but cannot determine the vehicle type for the remaining four percent, you may generate credits for all the engines in the family.

(c) As described in § 1036.730, compliance with the requirements of this subpart is determined at the end of the model year based on actual U.S.-directed production volumes. Keep appropriate records to document these production volumes. Do not include any of the following engines to calculate emission credits:

(1) Engines that you do not certify to the CO_2 standards of this part because they are permanently exempted under subpart G of this part or under 40 CFR part 1068.

(2) Exported engines.

(3) Engines not subject to the requirements of this part, such as those excluded under § 1036.5. For example, do not include engines used in vehicles certified to the greenhouse gas standards of 40 CFR 86.1819.

(4) Any other engines if we indicate elsewhere in this part 1036 that they are not to be included in the calculations of this subpart.

(d) You may use CO_2 emission credits to show compliance with CH_4 and/or N_2O FELs instead of the otherwise applicable emission standards. To do this, calculate the CH_4 and/or N_2O emission credits needed (negative credits) using the equation in paragraph (b) of this section, using the FEL(s) you specify for your engines during certification instead of the FCL. You must use 25 Mg of positive CO_2 credits to offset 1 Mg of negative CH_4 credits. You must use 298 Mg of positive CO_2 credits to offset 1 Mg of negative N_2O credits.

§ 1036.710 Averaging.

(a) Averaging is the exchange of emission credits among your engine families. You may average emission credits only within the same averaging set.

(b) You may certify one or more engine families to an FCL above the applicable standard, subject to any applicable FEL caps and other the provisions in subpart B of this part, if you show in your application for certification that your projected balance of all emission-credit transactions in that model year is greater than or equal to zero, or that a negative balance is allowed under § 1036.745.

(c) If you certify an engine family to an FCL that exceeds the otherwise applicable standard, you must obtain enough emission credits to offset the engine family's deficit by the due date for the final report required in § 1036.730. The emission credits used to address the deficit may come from your other engine families that generate emission credits in the same model year (or from later model years as specified in § 1036.745), from emission credits you have banked, or from emission credits you obtain through trading.

§ 1036.715 Banking.

(a) Banking is the retention of surplus emission credits by the manufacturer generating the emission credits for use in future model years for averaging or trading.

(b) You may designate any emission credits you plan to bank in the reports you submit under § 1036.730 as reserved credits. During the model year and before the due date for the final report, you may designate your reserved emission credits for averaging or trading.

(c) Reserved credits become actual emission credits when you submit your final report. However, we may revoke these emission credits if we are unable to verify them after reviewing your reports or auditing your records.

(d) Banked credits retain the designation of the averaging set in which they were generated.

§ 1036.720 Trading.

(a) Trading is the exchange of emission credits between manufacturers. You may use traded emission credits for averaging, banking, or further trading transactions. Traded emission credits remain subject to the averaging-set restrictions based on the averaging set in which they were generated.

(b) You may trade actual emission credits as described in this subpart. You may also trade reserved emission credits, but we may revoke these emission credits based on our review of your records or reports or those of the company with which you traded emission credits. You may trade banked credits within an averaging set to any certifying manufacturer.

(c) If a negative emission credit balance results from a transaction, both the buyer and seller are liable, except in cases we deem to involve fraud. See § 1036.255(e) for cases involving fraud. We may void the certificates of all engine families participating in a trade that results in a manufacturer having a negative balance of emission credits. See § 1036.745.

§ 1036.725 What must I include in my application for certification?

(a) You must declare in your application for certification your intent to use the provisions of this subpart for each engine family that will be certified using the ABT program. You must also declare the FELs/FCL you select for the engine family for each pollutant for which you are using the ABT program. Your FELs must comply with the specifications of subpart B of this part, including the FEL caps. FELs/FCLs must be expressed to the same number of decimal places as the applicable standards.

(b) Include the following in your application for certification:

(1) A statement that, to the best of your belief, you will not have a negative balance of emission credits for any averaging set when all emission credits are calculated at the end of the year; or a statement that you will have a negative balance of emission credits for one or more averaging sets, but that it is allowed under § 1036.745.

(2) Detailed calculations of projected emission credits (positive or negative) based on projected U.S.-directed production volumes. We may require you to include similar calculations from your other engine families to project your net credit balances for the model year. If you project negative emission credits for a family, state the source of positive emission credits you expect to use to offset the negative emission credits.

§ 1036.730 ABT reports.

(a) If any of your engine families are certified using the ABT provisions of this subpart, you must send a final report by March 31 following the end of the model year. You may ask us to extend the deadline for the final report to April 30.

(b) Your final report must include the following information for each engine family participating in the ABT program:

(1) Engine-family designation and averaging set.

(2) The emission standards that would otherwise apply to the engine family.

(3) The FCL for each pollutant. If you change the FCL after the start of production, identify the date that you started using the new FCL and/or give the engine identification number for the first engine covered by the new FCL. In this case, identify each applicable FCL and calculate the positive or negative emission credits as specified in § 1036.225.

(4) The projected and actual U.S.-directed production volumes for the model year. If you changed an FCL during the model year, identify the actual production volume associated with each FCL.

(5) The transient cycle conversion factor for each engine configuration as described in § 1036.705.

(6) Useful life.

(7) Calculated positive or negative emission credits for the whole engine family. Identify any emission credits that you traded, as described in paragraph (d)(1) of this section.

(c) Your final report must include the following additional information:

(1) Show that your net balance of emission credits from all your participating engine families in each averaging set in the applicable model year is not negative, except as allowed under § 1036.745. Your credit tracking must account for the limitation on credit life under § 1036.740(d).

(2) State whether you will reserve any emission credits for banking.

(3) State that the report's contents are accurate.

(d) If you trade emission credits, you must send us a report within 90 days after the transaction, as follows:

(1) As the seller, you must include the following information in your report:

(i) The corporate names of the buyer and any brokers.

(ii) A copy of any contracts related to the trade.

(iii) The engine families that generated emission credits for the trade, including the number of emission credits from each family.

(2) As the buyer, you must include the following information in your report:

(i) The corporate names of the seller and any brokers.

(ii) A copy of any contracts related to the trade.

(iii) How you intend to use the emission credits, including the number of emission credits you intend to apply to each engine family (if known).

(e) Send your reports electronically to the Designated Compliance Officer using an approved information format. If you want to use a different format, send us a written request with justification for a waiver.

(f) Correct errors in your final report as follows:

(1) If you or we determine before the due date for the final report that errors mistakenly decreased your balance of emission credits, you may correct the errors and recalculate the balance of emission credits. You may not make these corrections for errors that are determined after the due date for the final report. If you report a negative balance of emission credits, we may disallow corrections under this paragraph (f)(1).

(2) If you or we determine anytime that errors mistakenly increased your balance of emission credits, you must correct the errors and recalculate the balance of emission credits.

§ 1036.735 Recordkeeping.

(a) You must organize and maintain your records as described in this section. We may review your records at any time.

(b) Keep the records required by this section for at least eight years after the due date for the final report. You may not use emission credits for any engines if you do not keep all the records required under this section. You must therefore keep these records to continue to bank valid credits. Store these records in any format and on any media, as long as you can promptly send us organized, written records in English if we ask for them. You must keep these records readily available. We may review them at any time.

(c) Keep a copy of the reports we require in §§ 1036.725 and 1036.730.

(d) Keep records of the engine identification number (usually the serial number) for each engine you produce that generates or uses emission credits under the ABT program. You may identify these numbers as a range. If you change the FEL after the start of production, identify the date you started using each FCL and the range of engine identification numbers associated with each FCL. You must also identify the purchaser and destination for each engine you produce to the extent this information is available.

(e) We may require you to keep additional records or to send us relevant information not required by this section in accordance with the Clean Air Act.

§ 1036.740 Restrictions for using emission credits.

The following restrictions apply for using emission credits:

(a) *Averaging sets.* Except as specified in paragraph (c) of this section, emission credits may be exchanged only within the following averaging sets:

(1) Spark-ignition engines.

(2) Compression-ignition light heavy-duty engines.

(3) Compression-ignition medium heavy-duty engines.

(4) Compression-ignition heavy heavy-duty engines.

(b) *Applying credits to prior year deficits.* Where your credit balance for the previous year is negative, you may apply credits to that credit deficit only after meeting your credit obligations for the current year.

(c) *Credits from hybrid engines and other advanced technologies.* Credits you generate under § 1036.615 may be used for any of the averaging sets identified in paragraph (a) of this section; you may also use those credits to demonstrate compliance with the CO_2 emission standards in 40 CFR 86.1819 and 40 CFR part 1037. Similarly, you may use advanced-technology credits generated under 40 CFR 86.1819–14(k)(7) or 40 CFR 1037.615 to demonstrate compliance with the CO_2 standards in this part. In the case of spark-ignition engines and compression-ignition light heavy-duty engines, you may not use more than 60,000 Mg of credits from other averaging sets in any model year.

(1) The maximum amount of CO_2 credits you may bring into the following service class groups is 60,000 Mg per model year:

(i) Spark-ignition engines, light heavy-duty compression-ignition engines, and light heavy-duty vehicles. This group comprises the averaging sets listed in paragraphs (a)(1) and (2) of this section and the averaging set listed in 40 CFR 1037.740(a)(1).

(ii) Medium heavy-duty compression-ignition engines and medium heavy-duty vehicles. This group comprises the averaging sets listed in paragraph (a)(3) of this section and 40 CFR 1037.740(a)(2).

(iii) Heavy heavy-duty compression-ignition engines and heavy heavy-duty vehicles. This group comprises the averaging sets listed in paragraph (a)(4) of this section and 40 CFR 1037.740(a)(3).

(2) The limit specified in paragraph (c)(1) of this section does not limit the amount of advanced technology credits that can be used within a service class group if they were generated in that same service class group.

(d) *Credit life.* Credits may be used only for five model years after the year in which they are generated. For example, credits you generate in model year 2018 may be used to demonstrate compliance with emission standards only through model year 2023.

(e) *Other restrictions.* Other sections of this part specify additional restrictions for using emission credits under certain special provisions.

§ 1036.745 End-of-year CO_2 credit deficits.

Except as allowed by this section, we may void the certificate of any engine family certified to an FCL above the applicable standard for which you do not have sufficient credits by the deadline for submitting the final report.

(a) Your certificate for an engine family for which you do not have sufficient CO_2 credits will not be void if you remedy the deficit with surplus credits within three model years. For example, if you have a credit deficit of 500 Mg for an engine family at the end of model year 2015, you must generate (or otherwise obtain) a surplus of at least 500 Mg in that same averaging set by the end of model year 2018.

(b) You may not bank or trade away CO_2 credits in the averaging set in any model year in which you have a deficit.

(c) You may apply only surplus credits to your deficit. You may not apply credits to a deficit from an earlier model year if they were generated in a model year for which any of your engine families for that averaging set had an end-of-year credit deficit.

(d) If you do not remedy the deficit with surplus credits within three model years, we may void your certificate for that engine family. Note that voiding a certificate applies *ab initio.* Where the net deficit is less than the total amount of negative credits originally generated by the family, we will void the certificate only with respect to the number of engines needed to reach the amount of the net deficit. For example, if the original engine family generated 500 Mg of negative credits, and the manufacturer's net deficit after three years was 250 Mg, we would void the certificate with respect to half of the engines in the family.

(e) For purposes of calculating the statute of limitations, the following actions are all considered to occur at the expiration of the deadline for offsetting a deficit as specified in paragraph (a) of this section:

(1) Failing to meet the requirements of paragraph (a) of this section.

(2) Failing to satisfy the conditions upon which a certificate was issued relative to offsetting a deficit.

(3) Selling, offering for sale, introducing or delivering into U.S. commerce, or importing vehicles that are found not to be covered by a certificate as a result of failing to offset a deficit.

§ 1036.750 What can happen if I do not comply with the provisions of this subpart?

(a) For each engine family participating in the ABT program, the certificate of conformity is conditioned upon full compliance with the provisions of this subpart during and after the model year. You are responsible to establish to our satisfaction that you fully comply with applicable requirements. We may void the certificate of conformity for an engine family if you fail to comply with any provisions of this subpart.

(b) You may certify your engine family to an FCL above an applicable standard based on a projection that you will have enough emission credits to offset the deficit for the engine family. See § 1036.745 for provisions specifying what happens if you cannot show in your final report that you have enough actual emission credits to offset a deficit for any pollutant in an engine family.

(c) We may void the certificate of conformity for an engine family if you fail to keep records, send reports, or give us information we request. Note that failing to keep records, send reports, or give us information we request is also a violation of 42 U.S.C. 7522(a)(2).

(d) You may ask for a hearing if we void your certificate under this section (see § 1036.820).

§ 1036.755 Information provided to the Department of Transportation.

After receipt of each manufacturer's final report as specified in § 1036.730 and completion of any verification testing required to validate the manufacturer's submitted final data, we will issue a report to the Department of Transportation with CO_2 emission information and will verify the accuracy of each manufacturer's equivalent fuel consumption data that required by NHTSA under 49 CFR 535.8. We will send a report to DOT for each engine manufacturer based on each regulatory category and subcategory, including sufficient information for NHTSA to determine fuel consumption and associated credit values. See 49 CFR 535.8 to determine if NHTSA deems submission of this information to EPA to also be a submission to NHTSA.

Subpart I—Definitions and Other Reference Information

§ 1036.801 Definitions.

The following definitions apply to this part. The definitions apply to all subparts unless we note otherwise. All undefined terms have the meaning the Act gives to them. The definitions follow:

Act means the Clean Air Act, as amended, 42 U.S.C. 7401–7671q.

Adjustable parameter has the meaning given in 40 CFR part 86.

Advanced technology means technology certified under 40 CFR 86.1819–14(k)(7), § 1036.615, or 40 CFR 1037.615.

Aftertreatment means relating to a catalytic converter, particulate filter, or any other system, component, or technology mounted downstream of the exhaust valve (or exhaust port) whose design function is to decrease emissions in the engine exhaust before it is exhausted to the environment. Exhaust-gas recirculation (EGR) and turbochargers are not aftertreatment.

Aircraft means any vehicle capable of sustained air travel more than 100 feet above the ground.

Alcohol-fueled engine mean an engine that is designed to run using an alcohol fuel. For purposes of this definition, alcohol fuels do not include fuels with a nominal alcohol content below 25 percent by volume.

Auxiliary emission control device means any element of design that senses temperature, motive speed, engine rpm, transmission gear, or any other parameter for the purpose of activating, modulating, delaying, or deactivating the operation of any part of the emission control system.

Averaging set has the meaning given in § 1036.740.

Calibration means the set of specifications and tolerances specific to a particular design, version, or application of a component or assembly capable of functionally describing its operation over its working range.

Carryover means relating to certification based on emission data generated from an earlier model year as described in § 1036.235(d).

Certification means relating to the process of obtaining a certificate of conformity for an engine family that complies with the emission standards and requirements in this part.

Certified emission level means the highest deteriorated emission level in an engine family for a given pollutant from the applicable transient and/or steady-state testing, rounded to the same number of decimal places as the applicable standard. Note that you may have two certified emission levels for CO_2 if you certify a family for both vocational and tractor use.

Complete vehicle means a vehicle meeting the definition of complete vehicle in 40 CFR 1037.801 when it is first sold as a vehicle. For example, where a vehicle manufacturer sells an incomplete vehicle to a secondary manufacturer, the vehicle is not a complete vehicle under this part, even after its final assembly.

Compression-ignition means relating to a type of reciprocating, internal-combustion engine that is not a spark-ignition engine. Note that § 1036.1 also deems gas turbine engines and other engines to be compression-ignition engines. Note also that certain spark-ignition engines are subject to the requirements for compression-ignition engines.

Crankcase emissions means airborne substances emitted to the atmosphere from any part of the engine crankcase's ventilation or lubrication systems. The crankcase is the housing for the crankshaft and other related internal parts.

Criteria pollutants means emissions of NO_X, HC, PM, and CO. Note that these pollutants are also sometimes described collectively as ''non-greenhouse gas pollutants'', although they do not necessarily have negligible global warming potentials.

Designated Compliance Officer means one of the following:

(1) For compression-ignition engines, *Designated Compliance Officer* means Director, Diesel Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *complianceinfo@epa.gov; epa.gov/otaq/verify/*

(2) For spark-ignition engines, *Designated Compliance Officer* means Director, Gasoline Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *nonroad-si-cert@epa.gov; epa.gov/otaq/verify.*

Deteriorated emission level means the emission level that results from applying the appropriate deterioration factor to the official emission result of the emission-data engine. Note that where no deterioration factor applies, references in this part to the *deteriorated emission level* mean the official emission result.

Deterioration factor means the relationship between emissions at the end of useful life (or point of highest emissions if it occurs before the end of useful life) and emissions at the low-hour/low-mileage test point, expressed in one of the following ways:

(1) For multiplicative deterioration factors, the ratio of emissions at the end of useful life (or point of highest emissions) to emissions at the low-hour test point.

(2) For additive deterioration factors, the difference between emissions at the end of useful life (or point of highest emissions) and emissions at the low-hour test point.

Dual-fuel means relating to an engine designed for operation on two different types of fuel but not on a continuous mixture of those fuels (see § 1036.601(d). For purposes of this part, such an engine remains a dual-fuel engine even if it is designed for operation on three or more different fuels.

Emission control system means any device, system, or element of design that controls or reduces the emissions of regulated pollutants from an engine.

Emission-data engine means an engine that is tested for certification. This includes engines tested to establish deterioration factors.

Emission-related maintenance means maintenance that substantially affects emissions or is likely to substantially affect emission deterioration.

Engine configuration means a unique combination of engine hardware and calibration (related to the emission standards) within an engine family. Engines within a single engine configuration differ only with respect to normal production variability or factors unrelated to compliance with emission standards.

Engine family has the meaning given in § 1036.230.

Excluded means relating to engines that are not subject to some or all of the requirements of this part as follows:

(1) An engine that has been determined not to be a heavy-duty engine is excluded from this part.

(2) Certain heavy-duty engines are excluded from the requirements of this part under § 1036.5.

(3) Specific regulatory provisions of this part may exclude a heavy-duty engine generally subject to this part from one or more specific standards or requirements of this part.

Exempted has the meaning given in 40 CFR 1068.30.

Exhaust-gas recirculation means a technology that reduces emissions by routing exhaust gases that had been exhausted from the combustion chamber(s) back into the engine to be mixed with incoming air before or during combustion. The use of valve timing to increase the amount of residual exhaust gas in the combustion chamber(s) that is mixed with incoming air before or during combustion is not considered exhaust-gas recirculation for the purposes of this part.

Family certification level (FCL) means a CO_2 emission level declared by the manufacturer that is at or above emission test results for all emission-data engines. The FCL serves as the emission standard for the engine family with respect to certification testing if it is different than the otherwise applicable standard. The FCL must be expressed to the same number of decimal places as the emission standard it replaces.

Family emission limit (FEL) means an emission level declared by the manufacturer to serve in place of an otherwise applicable emission standard (other than CO_2 standards) under the ABT program in subpart H of this part. The FEL must be expressed to the same number of decimal places as the emission standard it replaces. The FEL serves as the emission standard for the engine family with respect to all required testing except certification testing for CO_2. The CO_2 FEL is equal to the CO_2 FCL multiplied by 1.03 and rounded to the same number of decimal places as the standard (*e.g.,* the nearest whole g/hp-hr for the 2016 CO_2 standards).

Flexible-fuel means relating to an engine designed for operation on any mixture of two or more different types of fuels (see § 1036.601(d).

Fuel type means a general category of fuels such as diesel fuel, gasoline, or natural gas. There can be multiple grades within a single fuel type, such as premium gasoline, regular gasoline, or gasoline with 10 percent ethanol.

Good engineering judgment has the meaning given in 40 CFR 1068.30. See 40 CFR 1068.5 for the administrative process we use to evaluate good engineering judgment.

Greenhouse gas means one or more compounds regulated under this part based primarily on their impact on the climate. This generally includes CO_2, CH_4, and N_2O.

Greenhouse gas emissions model (GEM) means the GEM simulation tool described in 40 CFR 1037.520. Note that an updated version of GEM applies starting in model year 2021 (see 40 CFR 1037.810).

Gross vehicle weight rating (GVWR) means the value specified by the vehicle manufacturer as the maximum design loaded weight of a single vehicle, consistent with good engineering judgment.

Heavy-duty engine means any engine which the engine manufacturer could reasonably expect to be used for motive power in a heavy-duty vehicle. For purposes of this definition in this part, the term ''engine'' includes internal combustion engines and other devices that convert chemical fuel into motive power. For example, a fuel cell or a gas turbine used in a heavy-duty vehicle is a heavy-duty engine.

Heavy-duty vehicle means any motor vehicle above 8,500 pounds GVWR or that has a vehicle curb weight above 6,000 pounds or that has a basic vehicle frontal area greater than 45 square feet. *Curb weight* has the meaning given in 40 CFR 86.1803. *Basic vehicle frontal area* has the meaning given in 40 CFR 86.1803.

Hybrid means relating to an engine or powertrain that includes energy storage features other than a conventional battery system or conventional flywheel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems. Note that certain provisions in this part treat hybrid engines and powertrains intended for vehicles that include regenerative braking different than those intended for vehicles that do not include regenerative braking.

Hydrocarbon (HC) means the hydrocarbon group on which the emission standards are based for each fuel type. For alcohol-fueled engines, HC means nonmethane hydrocarbon equivalent (NMHCE). For all other engines, HC means nonmethane hydrocarbon (NMHC).

Identification number means a unique specification (for example, a model number/serial number combination) that allows someone to distinguish a particular engine from other similar engines.

Incomplete vehicle means a vehicle meeting the definition of incomplete vehicle in 40 CFR 1037.801 when it is first sold as a vehicle.

Innovative technology means technology certified under § 1036.610.

Liquefied petroleum gas (LPG) means a liquid hydrocarbon fuel that is stored under pressure and is composed primarily of nonmethane compounds that are gases at atmospheric conditions. Note that, although this commercial term includes the word ''petroleum'', LPG is not considered to be a petroleum fuel under the definitions of this section.

Low-hour means relating to an engine that has stabilized emissions and represents the undeteriorated emission level. This would generally involve less than 125 hours of operation.

Manufacture means the physical and engineering process of designing, constructing, and/or assembling a heavy-duty engine or a heavy-duty vehicle.

Manufacturer has the meaning given in section 216(1) of the Act. In general, this term includes any person who manufactures or assembles an engine, vehicle, or piece of equipment for sale in the United States or otherwise introduces a new engine into commerce in the United States. This includes importers who import engines or vehicles for resale.

Medium-duty passenger vehicle has the meaning given in 40 CFR 86.1803.

Model year means the manufacturer's annual new model production period, except as restricted under this definition. It must include January 1 of the calendar year for which the model year is named, may not begin before January 2 of the previous calendar year, and it must end by December 31 of the named calendar year. Manufacturers may not adjust model years to circumvent or delay compliance with emission standards or to avoid the obligation to certify annually.

Motor vehicle has the meaning given in 40 CFR 85.1703.

Natural gas means a fuel whose primary constituent is methane.

New motor vehicle engine has the meaning given in the Act. This generally means a motor vehicle engine meeting the criteria of either paragraph (1), (2), or (3) of this definition.

(1) A motor vehicle engine for which the ultimate purchaser has never received the equitable or legal title is a n*ew motor vehicle engine.* This kind of engine might commonly be thought of as ''brand new'' although a *new motor vehicle engine* may include previously used parts. Under this definition, the engine is new from the time it is produced until the ultimate purchaser receives the title or places it into service, whichever comes first.

(2) An imported motor vehicle engine is a *new motor vehicle engine* if it was originally built on or after January 1, 1970.

(3) Any motor vehicle engine installed in a new motor vehicle.

Noncompliant engine means an engine that was originally covered by a certificate of conformity, but is not in the certified configuration or otherwise does not comply with the conditions of the certificate.

Nonconforming engine means an engine not covered by a certificate of conformity that would otherwise be subject to emission standards.

Nonmethane hydrocarbon (NMHC) means the sum of all hydrocarbon species except methane, as measured according to 40 CFR part 1065.

Nonmethane hydrocarbon equivalent has the meaning given in 40 CFR 1065.1001.

Off-cycle technology means technology certified under § 1036.610.

Official emission result means the measured emission rate for an emission-data engine on a given duty cycle before the application of any deterioration factor, but after the applicability of any required regeneration or other adjustment factors.

Owners manual means a document or collection of documents prepared by the engine or vehicle manufacturer for the owner or operator to describe appropriate engine maintenance, applicable warranties, and any other information related to operating or keeping the engine. The owners manual is typically provided to the ultimate purchaser at the time of sale.

Oxides of nitrogen has the meaning given in 40 CFR 1065.1001.

Percent has the meaning given in 40 CFR 1065.1001. Note that this means percentages identified in this part are assumed to be infinitely precise without regard to the number of significant figures. For example, one percent of 1,493 is 14.93.

Petroleum means gasoline or diesel fuel or other fuels normally derived from crude oil. This does not include methane or LPG.

Placed into service means put into initial use for its intended purpose, excluding incidental use by the manufacturer or a dealer.

Preliminary approval means approval granted by an authorized EPA representative prior to submission of an application for certification, consistent with the provisions of § 1036.210.

Primary intended service class has the meaning given in § 1036.140.

Rechargeable Energy Storage System (RESS) means the component(s) of a hybrid engine or vehicle that store recovered energy for later use, such as the battery system in an electric hybrid vehicle.

Revoke has the meaning given in 40 CFR 1068.30.

Round has the meaning given in 40 CFR 1065.1001.

Scheduled maintenance means adjusting, repairing, removing, disassembling, cleaning, or replacing components or systems periodically to keep a part or system from failing, malfunctioning, or wearing prematurely. It also may mean actions you expect are necessary to correct an overt indication of failure or malfunction for which periodic maintenance is not appropriate.

Small manufacturer means a manufacturer meeting the criteria specified in 13 CFR 121.201. The employee and revenue limits apply to the total number of employees and total revenue together for affiliated companies. Note that manufacturers with low production volumes may or may not be ''small manufacturers''.

Spark-ignition means relating to a gasoline-fueled engine or any other type of engine with a spark plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle. Spark-ignition engines usually use a throttle to regulate intake air flow to control power during normal operation. Note that some spark-ignition engines are subject to requirements that apply for compression-ignition engines as described in § 1036.140.

Steady-state has the meaning given in 40 CFR 1065.1001.

Suspend has the meaning given in 40 CFR 1068.30.

Test engine means an engine in a test sample.

Test sample means the collection of engines selected from the population of an engine family for emission testing. This may include testing for certification, production-line testing, or in-use testing.

Tractor means a vehicle meeting the definition of ''tractor'' in 40 CFR 1037.801, but not classified as a ''vocational tractor'' under 40 CFR 1037.630, or relating to such a vehicle.

Tractor engine means an engine certified for use in tractors. Where an engine family is certified for use in both tractors and vocational vehicles, ''tractor engine'' means an engine that the engine manufacturer reasonably believes will be (or has been) installed in a tractor. Note that the provisions of this part may require a manufacturer to document how it determines that an engine is a tractor engine.

Ultimate purchaser means, with respect to any new engine or vehicle, the first person who in good faith purchases such new engine or vehicle for purposes other than resale.

United States has the meaning given in 40 CFR 1068.30.

Upcoming model year means for an engine family the model year after the one currently in production.

U.S.-directed production volume means the number of engines, subject to the requirements of this part, produced by a manufacturer for which the manufacturer has a reasonable assurance that sale was or will be made to ultimate purchasers in the United States. This does not include engines certified to state emission standards that are different than the emission standards in this part.

Vehicle has the meaning given in 40 CFR 1037.801.

Vocational engine means an engine certified for use in vocational vehicles. Where an engine family is certified for use in both tractors and vocational vehicles, ''vocational engine'' means an engine that the engine manufacturer reasonably believes will be (or has been) installed in a vocational vehicle. Note that the provisions of this part may require a manufacturer to document how it determines that an engine is a vocational engine.

Vocational vehicle means a vehicle meeting the definition of ''vocational'' vehicle in 40 CFR 1037.801.

Void has the meaning given in 40 CFR 1068.30.

We (us, our) means the Administrator of the Environmental Protection Agency and any authorized representatives.

§ 1036.805 Symbols, abbreviations, and acronyms.

The procedures in this part generally follow either the International System of Units (SI) or the United States customary units, as detailed in NIST Special Publication 811, which we incorporate by reference in § 1036.810. See 40 CFR 1065.20 for specific provisions related to these conventions. This section summarizes the way we use symbols, units of measure, and other abbreviations.

(a) *Symbols for chemical species.* This part uses the following symbols for chemical species and exhaust constituents:

Symbol	Species
C	carbon.
CH_4	methane.
CH_4N_2O	urea.
CO	carbon monoxide.
CO_2	carbon dioxide.
H_2O	water.
HC	hydrocarbon.
NMHC	nonmethane hydrocarbon.
NMHCE	nonmethane hydrocarbon equivalent.
NO	nitric oxide.
NO_2	nitrogen dioxide.
NO_X	oxides of nitrogen.
N_2O	nitrous oxide.
PM	particulate matter.
THC	total hydrocarbon.
THCE	total hydrocarbon equivalent.

(b) *Symbols for quantities.* This part uses the following symbols and units of measure for various quantities:

Symbol	Quantity	Unit	Unit symbol	Unit in terms of SI base units
α	atomic hydrogen-to-carbon ratio	mole per mole	mol/mol	1
β	atomic oxygen-to-carbon ratio	mole per mole	mol/mol	1
e	mass weighted emission result	grams/ton-mile	g/ton-mi	g/kg-km
E_m	mass-specific net energy content	megajoules/kilogram	MJ/kg	$m^2 \cdot s^{-2}$
f_n	angular speed (shaft)	revolutions per minute	r/min	$\pi \cdot 30 \cdot s^{-1}$
m	mass	pound mass or kilogram	lbm or kg	kg
M	molar mass	gram per mole	g/mol	$10^{-3} \cdot kg \cdot mol^{-1}$
MF	mass fraction			
P	power	kilowatt	kW	$10^3 \cdot m^2 \cdot kg \cdot s^{-3}$
T	torque (moment of force)	newton meter	N·m	$m^2 \cdot kg \cdot s^{-2}$
W	work	kilowatt-hour	kW·hr	$3.6 \cdot m^2 \cdot kg \cdot s^{-1}$
w_C	carbon mass fraction	gram/gram	g/g	1
x	amount of substance mole fraction	mole per mole	mol/mol	1
x_b	brake energy fraction			
x_{bl}	brake energy limit			

(c) *Superscripts.* This part uses the following superscripts to define a quantity:

Superscript	Quantity
overbar (such as $\bar{y}$)	arithmetic mean.
overdot (such as $\dot{y}$)	quantity per unit time.

(d) *Subscripts.* This part uses the following subscripts to define a quantity:

Subscript	Quantity
acc	accessory.
Ccombdry	carbon from fuel per mole of dry exhaust.
CO2urea	CO_2 from urea decomposition.
cor	corrected.
cycle	test cycle.
exh	raw exhaust.
fuel	fuel.
H2Oexhaustdry	H_2O in exhaust per mole of exhaust.
idle	idle.
max	maximum.
mapped	mapped.
meas	measured quantity.
neg	negative.
mapped	mapped.
pos	positive.
ref	reference quantity.
stall	stall.
test	test.

(e) *Other acronyms and abbreviations.* This part uses the following additional abbreviations and acronyms:

ABT	averaging, banking, and trading.
AECD	auxiliary emission control device.
ASTM	American Society for Testing and Materials.
BTU	British thermal units.
CFR	Code of Federal Regulations.
DF	deterioration factor.
DOT	Department of Transportation.
E85	gasoline blend including nominally 85 percent denatured ethanol.
EPA	Environmental Protection Agency.
FCL	Family Certification Level.
FEL	Family Emission Limit.
GEM	Greenhouse gas Emissions Model.
g/hp-hr	grams per brake horsepower-hour.
GVWR	gross vehicle weight rating.
LPG	liquefied petroleum gas.
NARA	National Archives and Records Administration.
NHTSA	National Highway Traffic Safety Administration.
NTE	not-to-exceed.
RESS	rechargeable energy storage system.
RMC	ramped-modal cycle.
rpm	revolutions per minute.
SCR	Selective catalytic reduction.
U.S	United States.
U.S.C	United States Code.

(f) *Prefixes.* This part uses the following prefixes to define a quantity:

Symbol	Quantity	Value
µ	micro	10^{6}
m	milli	10^{-3}
c	centi	10^{-2}
k	kilo	10^3
M	mega	10^6

§ 1036.810 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Environmental Protection Agency must publish a notice of the change in the **Federal Register** and the material must be available to the public. All approved material is available for inspection at U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave. NW., Room B102, EPA West Building, Washington, DC 20460, (202) 202–1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

(b) American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959, (610) 832–9585, *http://www.astm.org/*.

(1) ASTM D240–14 Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter, approved October 1, 2014, (''ASTM D240''), IBR approved for § 1036.530(b).

(2) ASTM D4809–13 Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method), approved May 1, 2013, (''ASTM D4809''), IBR approved for § 1036.530(b).

(c) National Institute of Standards and Technology, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899–1070, (301) 975–6478, or *www.nist.gov*.

(1) NIST Special Publication 811, 2008 Edition, Guide for the Use of the International System of Units (SI), March 2008, IBR approved for § 1036.805.

(2) [Reserved]

§ 1036.815 Confidential information.

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

§ 1036.820 Requesting a hearing.

(a) You may request a hearing under certain circumstances, as described elsewhere in this part. To do this, you must file a written request, including a description of your objection and any supporting data, within 30 days after we make a decision.

(b) For a hearing you request under the provisions of this part, we will approve your request if we find that your request raises a substantial factual issue.

(c) If we agree to hold a hearing, we will use the procedures specified in 40 CFR part 1068, subpart G.

§ 1036.825 Reporting and recordkeeping requirements.

(a) This part includes various requirements to submit and record data or other information. Unless we specify otherwise, store required records in any format and on any media and keep them readily available for eight years after you send an associated application for certification, or eight years after you generate the data if they do not support an application for certification. You are expected to keep your own copy of required records rather than relying on someone else to keep records on your behalf. We may review these records at any time. You must promptly send us organized, written records in English if we ask for them. We may require you to submit written records in an electronic format.

(b) The regulations in § 1036.255 and 40 CFR 1068.25 and 1068.101 describe your obligation to report truthful and complete information. This includes information not related to certification. Failing to properly report information and keep the records we specify violates 40 CFR 1068.101(a)(2), which may involve civil or criminal penalties.

(c) Send all reports and requests for approval to the Designated Compliance Officer (see § 1036.801).

(d) Any written information we require you to send to or receive from another company is deemed to be a required record under this section. Such records are also deemed to be submissions to EPA. Keep these records for eight years unless the regulations specify a different period. We may require you to send us these records whether or not you are a certificate holder.

(e) Under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*), the Office of Management and Budget approves the reporting and recordkeeping specified in the applicable regulations. The following items illustrate the kind of reporting and recordkeeping we require for engines and vehicles regulated under this part:

(1) We specify the following requirements related to engine certification in this part 1036:

(i) In § 1036.135 we require engine manufacturers to keep certain records related to duplicate labels sent to vehicle manufacturers.

(ii) In subpart C of this part we identify a wide range of information required to certify engines.

(iii) In subpart G of this part we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various special compliance provisions.

(iv) In §§ 1036.725, 1036.730, and 1036.735 we specify certain records related to averaging, banking, and trading.

(2) We specify the following requirements related to testing in 40 CFR part 1065:

(i) In 40 CFR 1065.2 we give an overview of principles for reporting information.

(ii) In 40 CFR 1065.10 and 1065.12 we specify information needs for establishing various changes to published test procedures.

(iii) In 40 CFR 1065.25 we establish basic guidelines for storing test information.

(iv) In 40 CFR 1065.695 we identify the specific information and data items to record when measuring emissions.

(3) We specify the following requirements related to the general compliance provisions in 40 CFR part 1068:

(i) In 40 CFR 1068.5 we establish a process for evaluating good engineering judgment related to testing and certification.

(ii) In 40 CFR 1068.25 we describe general provisions related to sending and keeping information.

(iii) In 40 CFR 1068.27 we require manufacturers to make engines available for our testing or inspection if we make such a request.

(iv) In 40 CFR 1068.105 we require vehicle manufacturers to keep certain records related to duplicate labels from engine manufacturers.

(v) In 40 CFR 1068.120 we specify recordkeeping related to rebuilding engines.

(vi) In 40 CFR part 1068, subpart C, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various exemptions.

(vii) In 40 CFR part 1068, subpart D, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to importing engines.

(viii) In 40 CFR 1068.450 and 1068.455 we specify certain records related to testing production-line engines in a selective enforcement audit.

(ix) In 40 CFR 1068.501 we specify certain records related to investigating and reporting emission-related defects.

(x) In 40 CFR 1068.525 and 1068.530 we specify certain records related to recalling nonconforming engines.

■ 116. Part 1037 is revised to read as follows:

PART 1037—CONTROL OF EMISSIONS FROM NEW HEAVY–DUTY MOTOR VEHICLES

Authority: 42 U.S.C. 7401–7671q.

Subpart A—Overview and Applicability

§ 1037.1 Applicability.

(a) This part contains standards and other regulations applicable to the emission of the air pollutant defined as the aggregate group of six greenhouse gases: Carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perflurocarbons, and sulfur hexafluoride. The regulations in this part 1037 apply for all new heavy-duty vehicles, except as provided in §§ 1037.5 and 1037.104. This includes electric vehicles and vehicles fueled by conventional and alternative fuels. This also includes certain trailers as described in §§ 1037.5, 1037.150, and 1037.801.

(b) The provisions of this part apply for alternative fuel conversions as specified in 40 CFR part 85, subpart F.

§ 1037.2 Who is responsible for compliance?

The regulations in this part 1037 contain provisions that affect both vehicle manufacturers and others. However, the requirements of this part are generally addressed to the vehicle manufacturer(s). The term ''you'' generally means the vehicle manufacturer(s), especially for issues related to certification. Additional requirements and prohibitions apply to other persons as specified in § 1037.601 and 40 CFR part 1068.

§ 1037.5 Excluded vehicles.

Except for the definitions specified in § 1037.801, this part does not apply to the following vehicles:

(a) Vehicles not meeting the definition of ''motor vehicle'' in § 1037.801.

(b) Vehicles excluded from the definition of ''heavy-duty vehicle'' in § 1037.801 because of vehicle weight, weight rating, and frontal area (such as light-duty vehicles and light-duty trucks).

(c) Vehicles produced in model years before 2014, unless they are certified under § 1037.150.

(d) Medium-duty passenger vehicles and other vehicles subject to the light-duty greenhouse gas standards of 40 CFR part 86. See 40 CFR 86.1818 for greenhouse gas standards that apply for these vehicles. An example of such a vehicle would be a vehicle meeting the definition of ''heavy-duty vehicle'' in § 1037.801 and 40 CFR 86.1803, but also meeting the definition of ''light truck'' in 40 CFR 86.1818–12(b)(2).

(e) Vehicles subject to the heavy-duty greenhouse gas standards of 40 CFR part 86. See 40 CFR 86.1819 for greenhouse gas standards that apply for these vehicles. This generally applies for complete heavy-duty vehicles at or below 14,000 pounds GVWR.

(f) Aircraft meeting the definition of ''motor vehicle''. For example, this would include certain convertible aircraft that can be adjusted to operate on public roads. Standards apply separately to certain aircraft engines, as described in 40 CFR part 87.

(g) Trailers meeting one or more of the following characteristics:

(1) Trailers designed specifically for in-field operations in logging or mining.

(2) Trailers designed to operate at low speeds such that they are unsuitable for normal highway operation.

(3) Trailers with permanently affixed components designed for heavy construction that allow the trailer to perform its primary function while stationary. This would include crane trailers and concrete trailers. Trailers would not qualify under this paragraph (g)(3) based on welding equipment or other components that are commonly used separate from trailers.

(4) Trailers less than 35 feet long with three axles, and all trailers with four or more axles.

(5) Trailers intended for temporary or permanent residence, office space, or other work space, such as campers, mobile homes, and carnival trailers.

(6) Trailers designed specifically to transport livestock.

(7) Trailers built before January 1, 2018.

(8) Note that the definition of trailer in § 1037.801 excludes equipment that serves similar purposes but are not intended to be pulled by a tractor. For example, car-hauling equipment does not qualify as a trailer under this part if it is designed to be pulled by a heavy-duty vehicle with a pintle hook or hitch instead of a fifth wheel.

(h) Where it is unclear, you may ask us to make a determination regarding the exclusions identified in this section. We recommend that you make your request before you produce the vehicle.

§ 1037.10 How is this part organized?

This part 1037 is divided into the following subparts:

(a) Subpart A of this part defines the applicability of part 1037 and gives an overview of regulatory requirements.

(b) Subpart B of this part describes the emission standards and other requirements that must be met to certify vehicles under this part. Note that § 1037.150 discusses certain interim requirements and compliance provisions that apply only for a limited time.

(c) Subpart C of this part describes how to apply for a certificate of conformity for vehicles subject to the standards of § 1037.105 or § 1037.106.

(d) [Reserved]

(e) Subpart E of this part addresses testing of in-use vehicles.

(f) Subpart F of this part describes how to test your vehicles and perform emission modeling (including references to other parts of the Code of Federal Regulations) for vehicles subject to the standards of § 1037.105 or § 1037.106.

(g) Subpart G of this part and 40 CFR part 1068 describe requirements, prohibitions, and other provisions that apply to manufacturers, owners, operators, rebuilders, and all others. Section 1037.601 describes how 40 CFR part 1068 applies for heavy-duty vehicles.

(h) Subpart H of this part describes how you may generate and use emission credits to certify vehicles that are subject to the standards of § 1037.105 or § 1037.106.

(i) Subpart I of this part contains definitions and other reference information.

§ 1037.15 Do any other regulation parts apply to me?

(a) Parts 1065 and 1066 of this chapter describe procedures and equipment specifications for testing engines and vehicles to measure exhaust emissions. Subpart F of this part 1037 describes how to apply the provisions of part 1065 and part 1066 of this chapter to determine whether vehicles meet the exhaust emission standards in this part.

(b) As described in § 1037.601, certain requirements and prohibitions of part 1068 of this chapter apply to everyone, including anyone who manufactures, imports, installs, owns, operates, or rebuilds any of the vehicles subject to this part 1037. Part 1068 of this chapter describes general provisions that apply broadly, but do not necessarily apply for all vehicles or all persons. The issues addressed by these provisions include these seven areas:

(1) Prohibited acts and penalties for manufacturers and others.

(2) Rebuilding and other aftermarket changes.

(3) Exclusions and exemptions for certain vehicles.

(4) Importing vehicles.

(5) Selective enforcement audits of your production.

(6) Recall.

(7) Procedures for hearings.

(c) [Reserved]

(d) Other parts of this chapter apply if referenced in this part.

§ 1037.30 Submission of information.

Unless we specify otherwise, send all reports and requests for approval to the Designated Compliance Officer (see § 1037.801). See § 1037.825 for additional reporting and recordkeeping provisions.

Subpart B—Emission Standards and Related Requirements

§ 1037.101 Overview of emission standards for heavy-duty vehicles.

(a) This part specifies emission standards for certain vehicles and for certain pollutants. This part contains standards and other regulations applicable to the emission of the air pollutant defined as the aggregate group of six greenhouse gases: Carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perflurocarbons, and sulfur hexafluoride.

(b) The regulated emissions are addressed in four groups:

(1) *Exhaust emissions of NO_X, HC, PM, and CO.* These pollutants are sometimes described collectively as ''criteria pollutants'' because they are either criteria pollutants under the Clean Air Act or precursors to the criteria pollutant ozone. These pollutants are also sometimes described collectively as ''non-greenhouse gas pollutants'', although they do not necessarily have negligible global warming potential. As described in § 1037.102, standards for these pollutants are provided in 40 CFR part 86.

(2) *Exhaust emissions of CO_2, CH_4, and N_2O.* These pollutants are described collectively in this part as ''greenhouse gas pollutants'' because they are regulated primarily based on their impact on the climate. These standards are provided in §§ 1037.105 through 1037.107.

(3) *Hydrofluorocarbons.* These pollutants are also ''greenhouse gas pollutants'' but are treated separately from exhaust greenhouse gas pollutants

listed in paragraph (b)(2) of this section. These standards are provided in § 1037.115.

(4) *Fuel evaporative emissions.* These requirements are described in § 1037.103.

(c) The regulated heavy-duty vehicles are addressed in different groups as follows:

(1) For criteria pollutants, vocational vehicles and tractors are regulated based on gross vehicle weight rating (GVWR), whether they are considered ''spark-ignition'' or ''compression-ignition,'' and whether they are first sold as complete or incomplete vehicles.

(2) For greenhouse gas pollutants, vehicles are regulated in the following groups:

(i) Tractors above 26,000 pounds GVWR.

(ii) Trailers are subject to standards as specified in § 1037.107.

(iii) All other motor vehicles subject to standards under this part. These other vehicles are referred to as ''vocational'' vehicles.

(iv) The greenhouse gas emission standards in some cases apply differently for ''spark-ignition'' and ''compression-ignition'' engines or vehicles. Engine requirements are similarly differentiated, as described in 40 CFR 1036.140. References in this part 1037 to ''spark-ignition'' or ''compression-ignition'' defer to the application of standards under 40 CFR 1036.140. For example, any vehicle with an engine certified to spark-ignition standards under 40 CFR part 1036 is subject to requirements under this part 1037 that apply for spark-ignition vehicles.

(3) For evaporative and refueling emissions, vehicles are regulated based on the type of fuel they use. Vehicles fueled with volatile liquid fuels or gaseous fuels are subject to evaporative emission standards. Vehicles up to a certain size that are fueled with gasoline, diesel fuel, ethanol, methanol, or LPG are subject to refueling emission standards.

§ 1037.102 Exhaust emission standards for NO_X, HC, PM, and CO.

See 40 CFR part 86 for the exhaust emission standards for NO_X, HC, PM, and CO that apply for heavy-duty vehicles.

§ 1037.103 Evaporative and refueling emission standards.

(a) *Applicability.* Evaporative and refueling emission standards apply to heavy-duty vehicles as follows:

(1) Complete and incomplete heavy-duty vehicles at or below 14,000 pounds GVWR must meet evaporative and refueling emission standards as specified in 40 CFR part 86, subpart S, instead of the requirements specified in this section.

(2) Heavy-duty vehicles above 14,000 pounds GVWR that run on volatile liquid fuel (such as gasoline or ethanol) or gaseous fuel (such as natural gas or LPG) must meet evaporative and refueling emission standards as specified in this section.

(b) *Emission standards.* The evaporative and refueling emission standards and measurement procedures specified in 40 CFR 86.1813 apply for vehicles above 14,000 pounds GVWR, except as described in this section. The evaporative emission standards phase in over model years 2018 through 2022, with provisions allowing for voluntary compliance with the standards as early as model year 2015. Count vehicles subject to standards under this section the same as heavy-duty vehicles at or below 14,000 pounds GVWR to comply with the phase-in requirements specified in 40 CFR 86.1813. These vehicles may generate and use emission credits as described in 40 CFR part 86, subpart S, but only for vehicles that are tested for certification instead of relying on the provisions of paragraph (c) of this section. The following provisions apply instead of what is specified in 40 CFR 86.1813:

(1) The refueling standards in 40 CFR 86.1813–17(b) apply to complete vehicles starting in model year 2022; they are optional for incomplete vehicles.

(2) The leak standard in 40 CFR 86.1813–17(a)(4) does not apply.

(3) The FEL cap relative to the diurnal plus hot soak standard for low-altitude testing is 1.9 grams per test.

(4) The diurnal plus hot soak standard for high-altitude testing is 2.3 grams per test.

(5) Testing does not require measurement of exhaust emissions. Disregard references in subpart B of this part to procedures, equipment specifications, and recordkeeping related to measuring exhaust emissions. All references to the exhaust test under 40 CFR part 86, subpart B, are considered the ''dynamometer run'' as part of the evaporative testing sequence under this subpart.

(6) Vehicles not yet subject to the Tier 3 standards in 40 CFR 86.1813 must meet evaporative emission standards as specified in 40 CFR 86.008–10(b)(1) and (2) for Otto-cycle applications and 40 CFR 86.007–11(b)(3)(ii) and (b)(4)(ii) for diesel-cycle applications.

(c) *Compliance demonstration.* You may provide a statement in the application for certification that vehicles above 14,000 pounds GVWR comply with evaporative and refueling emission standards instead of submitting test data if you include an engineering analysis describing how vehicles include design parameters, equipment, operating controls, or other elements of design that adequately demonstrate that vehicles comply with the standards. We would expect emission control components and systems to exhibit a comparable degree of control relative to vehicles that comply based on testing. For example, vehicles that comply under this paragraph (c) should rely on comparable material specifications to limit fuel permeation, and components should be sized and calibrated to correspond with the appropriate fuel capacities, fuel flow rates, purge strategies, and other vehicle operating characteristics. You may alternatively show that design parameters are comparable to those for vehicles at or below 14,000 pounds GVWR certified under 40 CFR part 86, subpart S.

(d) *CNG refueling requirement.* Compressed natural gas vehicles must meet the requirements for fueling connection devices as specified in 40 CFR 86.1813–17(f)(1). Vehicles meeting these requirements are deemed to comply with evaporative and refueling emission standards.

(e) *LNG refueling requirement.* Liquefied natural gas vehicles must meet the requirements in Section 4.2 of SAE J2343 (incorporated by reference in § 1037.810), which specifies that vehicles meet a five-day hold time after a refueling event before the fuel reaches the point of venting to relieve pressure. This hold time starts immediately after a conventional refueling event corresponding to the vehicle's refueling fittings and other hardware, without any stabilization period to reach a different starting condition for the fuel in the tank. The vehicle must remain parked away from direct sun with ambient temperatures between (20 and 30) °C throughout the measurement procedure. This standard and procedure are consistent with Section 9.3.5 of NFPA 52, except that NFPA specifies a three-day hold time. Vehicles meeting these requirements are deemed to comply with evaporative and refueling emission standards. The provisions of this paragraph (e) are optional for vehicles produced before January 1, 2020.

(f) *Incomplete vehicles.* If you sell incomplete vehicles, you must identify the maximum fuel tank capacity for which you designed the vehicle's evaporative emission control system.

(g) *Useful life.* The evaporative emission standards of this section apply for the full useful life, expressed in service miles or calendar years, whichever comes first. The useful life values for the standards of this section are described in 40 CFR 86.1805.

(h) *Auxiliary engines and separate fuel systems.* The provisions of this paragraph (g) apply for vehicles with auxiliary engines. This includes any engines installed in the final vehicle configuration that contribute no motive power through the vehicle's transmission.

(1) Auxiliary engines and associated fuel-system components must be installed when testing complete vehicles. If the auxiliary engine draws fuel from a separate fuel tank, you must fill the extra fuel tank before the start of diurnal testing as described for the vehicle's main fuel tank. Use good engineering judgment to ensure that any nonmetal portions of the fuel system related to the auxiliary engine have reached stabilized levels of permeation emissions. The auxiliary engine must not operate during the running loss test or any other portion of testing under this section.

(2) For testing with incomplete vehicles, you may omit installation of auxiliary engines and associated fuel-system components as long as those components installed in the final configuration are certified to meet the applicable emission standards for Small SI equipment described in 40 CFR 1054.112 or for Large SI engines in 40 CFR 1048.105. For any fuel-system components that you do not install, your installation instructions must describe this certification requirement.

§ 1037.104 Exhaust emission standards for CO_2, CH_4, and N_2O for heavy-duty vehicles at or below 14,000 pounds GVWR.

Heavy-duty vehicles at or below 14,000 pounds GVWR are not subject to the provisions of this part 1037 if they are subject to 40 CFR part 86, subpart S, including all vehicles certified under 40 CFR part 86, subpart S. See 40 CFR 86.1819 and 86.1865 for detailed provisions that apply for these vehicles.

§ 1037.105 Exhaust emission standards for CO_2 for vocational vehicles.

(a) The standards of this section apply for the following vehicles:

(1) Vehicles above 14,000 pounds GVWR and at or below 26,000 pounds GVWR, but not certified to the vehicle standards in 40 CFR 86.1819.

(2) Vehicles above 26,000 pounds GVWR that are not tractors.

(3) Vocational tractors.

(4) Heavy-duty vehicles at or below 14,000 pounds GVWR that are excluded from the standards in 40 CFR 86.1819 or that use engines certified under § 1037.150(m).

(b) CO_2 standards apply as described in this paragraph (b). The provisions of § 1037.241 specify how to comply with these standards. Standards differ based on engine cycle, vehicle weight class, and intended vehicle duty cycle. See § 1037.510(c) to determine which duty cycle applies.

(1) Model year 2027 and later vehicles are subject to CO_2 standards corresponding to the selected subcategories as shown in the following table:

TABLE 1 OF § 1037.105—PHASE 2 CO_2 STANDARDS FOR MODEL YEAR 2027 AND LATER VOCATIONAL VEHICLES

[g/ton-mile]

Engine type	Vehicle size	Multi-purpose	Regional	Urban
Compression-ignition	Class 2b–5	280	292	272
Compression-ignition	Class 6–7	174	170	172
Compression-ignition	Class 8	183	174	182
Spark-ignition	Class 2b–5	308	321	299
Spark-ignition	Class 6–7	191	187	189
Spark-ignition	Class 8	198	188	196

(2) Model year 2024 through 2026 vehicles are subject to CO_2 standards corresponding to the selected subcategories as shown in the following table:

TABLE 2 OF § 1037.105—PHASE 2 CO_2 STANDARDS FOR MODEL YEAR 2024 AND LATER VOCATIONAL VEHICLES

[g/ton-mile]

Engine type	Vehicle size	Multi-purpose	Regional	Urban
Compression-ignition	Class 2b–5	292	304	284
Compression-ignition	Class 6–7	181	178	179
Compression-ignition	Class 8	192	182	190
Spark-ignition	Class 2b–5	321	334	312
Spark-ignition	Class 6–7	199	196	197
Spark-ignition	Class 8	210	199	208

(3) Model year 2021 through 2023 vehicles are subject to CO_2 standards corresponding to the selected subcategories as shown in the following table:

TABLE 3 OF § 1037.105—PHASE 2 CO_2 STANDARDS FOR MODEL YEAR 2021 THROUGH 2023 VOCATIONAL VEHICLES

[g/ton-mile]

Engine type	Vehicle size	Multi-purpose	Regional	Urban
Compression-ignition	Class 2b–5	305	318	296
Compression-ignition	Class 6–7	190	186	188
Compression-ignition	Class 8	200	189	198
Spark-ignition	Class 2b–5	329	343	320
Spark-ignition	Class 6–7	205	201	203
Spark-ignition	Class 8	216	204	214

(4) You may certify model year 2021 and later emergency vehicles to the CO_2 standards specified in Table 5 of this section instead of the standards specified in paragraphs (b)(1) through (3) of this section. Vehicles certified to these alternative standards may not generate emission credits.

TABLE 5 OF § 1037.105—ALTERNATIVE PHASE 2 CO_2 STANDARDS FOR EMERGENCY VEHICLES

[g/ton-mile]

Vehicle size	CO_2 standard
Class 2b–5	321
Class 6–7	201
Class 8	213

(5) Model year 2014 through 2020 vehicles are subject to Phase 1 CO_2 standards as shown in the following table:

TABLE 4 OF § 1037.105—PHASE 1 CO_2 STANDARDS FOR MODEL YEAR 2014 THROUGH 2020 VOCATIONAL VEHICLES

[g/ton-mile]

Vehicle size	CO_2 standard for model years 2014–2016	CO_2 standard for model year 2017 and later
Class 2b–5	388	373
Class 6–7	234	225
Class 8	226	222

(c) No CH_4 or N_2O standards apply under this section. See 40 CFR part 1036 for CH_4 or N_2O standards that apply to engines used in these vehicles.

(d) You may generate or use emission credits for averaging, banking, and trading as described in subpart H of this part. This requires that you specify a Family Emission Limit (FEL) for CO_2 for each vehicle subfamily. The FEL may not be less than the result of emission modeling from § 1037.520. These FELs serve as the emission standards for the vehicle subfamily instead of the standards specified in paragraph (b) of this section.

(e) The exhaust emission standards of this section apply for the full useful life, expressed in service miles or calendar years, whichever comes first. The following useful life values apply for the standards of this section:

(1) 150,000 miles or 15 years, whichever comes first, for Class 2b through Class 5 vehicles.

(2) 185,000 miles or 10 years, whichever comes first, for Class 6 and Class 7 vehicles.

(3) 435,000 miles or 10 years, whichever comes first, for Class 8 vehicles.

(f) See § 1037.631 for provisions that exempt certain vehicles used in off-road operation from the standards of this section.

(g) You may optionally certify a vocational vehicle to the standards and useful life applicable to a heavier vehicle service class (such as medium heavy-duty instead of light heavy-duty), provided you do not generate credits with the vehicle. If you include lighter vehicles in a credit-generating subfamily (with an FEL below the standard), exclude their production volume from the credit calculation. Conversely, if you include lighter vehicles in a credit-using subfamily, you must include their production volume in the credit calculation.

§ 1037.106 Exhaust emission standards for CO_2 for tractors above 26,000 pounds GVWR.

(a) The CO_2 standards of this section apply for tractors above 26,000 pounds GVWR. Note that the standards of this section do not apply for vehicles classified as ''vocational tractors'' under § 1037.630,

(b) The CO_2 standards for tractors above 26,000 pounds GVWR are given in Table 1 of this section. The provisions of § 1037.241 specify how to comply with these standards.

TABLE 1 OF § 1037.106—CO_2 STANDARDS FOR CLASS 7 AND CLASS 8 TRACTORS BY MODEL YEAR

[g/ton-mile]

Subcategory [1]	Phase 1 standards for model years 2014–2016	Phase 1 standards for model years 2017–2020	Phase 2 standards for model years 2021–2023	Phase 2 standards for model years 2024–2026	Phase 2 standards for model year 2027 and later
Class 7 Low-Roof (all cab styles)	107	104	97	90	87
Class 7 Mid-Roof (all cab styles)	119	115	107	100	96
Class 7 High-Roof (all cab styles)	124	120	109	101	96
Class 8 Low-Roof Day Cab	81	80	78	72	70

TABLE 1 OF § 1037.106—CO_2 STANDARDS FOR CLASS 7 AND CLASS 8 TRACTORS BY MODEL YEAR—Continued

[g/ton-mile]

Subcategory [1]	Phase 1 standards for model years 2014–2016	Phase 1 standards for model years 2017–2020	Phase 2 standards for model years 2021–2023	Phase 2 standards for model years 2024–2026	Phase 2 standards for model year 2027 and later
Class 8 Low-Roof Sleeper Cab	68	66	70	64	62
Class 8 Mid-Roof Day Cab	88	86	84	78	76
Class 8 Mid-Roof Sleeper Cab	76	73	78	71	69
Class 8 High-Roof Day Cab	92	89	86	79	76
Class 8 High-Roof Sleeper Cab	75	72	77	70	67
Heavy-Haul Tractors	....	....	54	52	51

[1] Sub-category terms are defined in § 1037.801.

(c) No CH_4 or N_2O standards apply under this section. See 40 CFR part 1036 for CH_4 or N_2O standards that apply to engines used in these vehicles.

(d) You may generate or use emission credits for averaging, banking, and trading as described in subpart H of this part. This requires that you calculate a credit quantity if you specify a Family Emission Limit (FEL) that is different than the standard specified in this section for a given pollutant. The FEL may not be less than the result of emission modeling from § 1037.520. These FELs serve as the emission standards for the specific vehicle subfamily instead of the standards specified in paragraph (a) of this section.

(e) The exhaust emission standards of this section apply for the full useful life, expressed in service miles or calendar years, whichever comes first. The following useful life values apply for the standards of this section:

(1) 185,000 miles or 10 years, whichever comes first, for vehicles at or below 33,000 pounds GVWR.

(2) 435,000 miles or 10 years, whichever comes first, for vehicles above 33,000 pounds GVWR.

(f) You may optionally certify a tractor to the standards and useful life applicable to a heavier vehicle service class (such as heavy heavy-duty instead of medium heavy-duty), provided you do not generate credits with the vehicle. If you include lighter vehicles in a credit-generating subfamily (with an FEL below the standard), exclude its production volume from the credit calculation. Conversely, if you include lighter vehicles in a credit-using subfamily, you must include their production volume in the credit calculation.

§ 1037.107 Emission standards for trailers.

The exhaust emission standards specified in this section apply to trailers based on the effect of trailer designs on the performance of the trailer in conjunction with a tractor; this accounts for the effect of the trailer on the tractor's exhaust emissions, even though trailers themselves have no exhaust emissions.

(a) Standards apply for trailers as follows:

(1) Different levels of stringency apply for box vans depending on features that may affect aerodynamic performance. You may optionally meet less stringent standards for different trailer types, which we characterize as follows:

(i) For trailers 35 feet or longer, ''non-aero trailers'' are box vans that have a rear lift gate or rear hinged ramp, and at least one of the following side features: side lift gate, belly box, side-mounted pull-out platform, steps for side-door access, or a drop-deck design. For trailers less than 35 feet long, ''non-aero trailers'' are refrigerated box vans with at least one of the side features identified for longer trailers.

(ii) ''Partial-aero trailers'' are box vans that have at least one of the side features identified in paragraph (a)(1)(i) of this section. Long box vans also qualify as partial-aero trailers if they have a rear lift gate or rear hinged ramp. Note that this paragraph (a)(1)(ii) does not apply for box vans designated as ''non-aero trailers'' under paragraph (a)(1)(i) of this section.

(iii) ''Full-aero trailers'' are box vans that do not meet the specifications of either paragraph (a)(1)(i) or (ii) of this section.

(2) CO_2 standards apply for full-aero trailers as specified in the following table:

TABLE 1 OF § 1037.107—PHASE 2 CO_2 STANDARDS FOR TRAILERS

[g/ton-mile]

Model year	Dry van		Refrigerated van	
	Short	Long	Short	Long
2018–2020	144	83	147	84
2021–2023	143	81	146	82
2024–2026	141	79	144	79
2027+	140	77	144	77

(3) Partial-aero trailers may continue to meet the 2024 standards in 2027 and later model years.

(4) Non-box trailers and non-aero trailers must meet standards as follows:

(i) Trailers must use qualified automatic tire inflation systems with wheels on all axles.

(ii) Trailers must use tires with a TRRL at or below 4.7 kg/ton. Through model year 2023, trailers may instead use tires with a TRRL at or below 5.1 kg/ton.

(5) You may generate or use emission credits for averaging to demonstrate compliance with the standards specified in paragraph (a)(2) of this section as described in subpart H of this part. This requires that you specify a Family Emission Limit (FEL) for CO_2 for each vehicle subfamily. The FEL may not be less than the result of the emission calculation in § 1037.515. These FELs serve as the emission standards for the

specific vehicle subfamily instead of the standards specified in paragraph (a) of this section. You may not use averaging for non-box trailers, partial-aero trailers, or non-aero trailers that meet standards under paragraph (a)(3) or (a)(4) of this section, and you may not use emission credits for banking or trading for any trailers.

(6) The provisions of § 1037.241 specify how to comply with the standards of this section.

(b) No CH_4, N_2O, or HFC standards apply under this section.

(c) The emission standards of this section apply for a useful life of 10 years.

§ 1037.115 Other requirements.

Vehicles required to meet the emission standards of this part must meet the following additional requirements, except as noted elsewhere in this part:

(a) *Adjustable parameters.* Vehicles that have adjustable parameters must meet all the requirements of this part for any adjustment in the physically adjustable range. We may require that you set adjustable parameters to any specification within the adjustable range during any testing. See 40 CFR 86.094–22 for information related to determining whether or not an operating parameter is considered adjustable. You must ensure safe vehicle operation throughout the physically adjustable range of each adjustable parameter, including consideration of production tolerances. Note that adjustable roof fairings and trailer rear fairings are deemed not to be adjustable parameters.

(b) *Prohibited controls.* You may not design your vehicles with emission control devices, systems, or elements of design that cause or contribute to an unreasonable risk to public health, welfare, or safety while operating. For example, this would apply if the vehicle emits a noxious or toxic substance it would otherwise not emit that contributes to such an unreasonable risk.

(c) [Reserved]

(d) *Defeat devices.* 40 CFR 1068.101 prohibits the use of defeat devices.

(e) *Air conditioning leakage.* Loss of refrigerant from your air conditioning systems may not exceed a total leakage rate of 11.0 grams per year or a percent leakage rate of 1.50 percent per year, whichever is greater. Calculate the total leakage rate in g/year as specified in 40 CFR 86.1867–12(a). Calculate the percent leakage rate as: [total leakage rate (g/yr)] ÷ [total refrigerant capacity (g)] × 100. Round your percent leakage rate to the nearest one-hundredth of a percent. This paragraph (e) does not apply for refrigeration units installed on trailers or for refrigeration units on vocational vehicles that are limited to cooling cargo.

(1) For purposes of this requirement, ''refrigerant capacity'' is the total mass of refrigerant recommended by the vehicle manufacturer as representing a full charge. Where full charge is specified as a pressure, use good engineering judgment to convert the pressure and system volume to a mass.

(2) If your system uses a refrigerant other than HFC–134a that is listed as an acceptable substitute refrigerant for heavy-duty vehicles under 40 CFR part 82, subpart G, and the substitute refrigerant is identified in 40 CFR 86.1867–12(e), your system is deemed to meet the leakage standard in this paragraph (e), consistent with good engineering judgment, and the leakage rate reporting requirement of § 1037.205(c)(1) does not apply. If your system uses any other refrigerant that is listed as an acceptable substitute refrigerant for heavy-duty vehicles under 40 CFR part 82, subpart G, contact us for procedures for calculating the leakage rate in a way that appropriately accounts for the refrigerant's properties.

§ 1037.120 Emission-related warranty requirements.

(a) *General requirements.* You must warrant to the ultimate purchaser and each subsequent purchaser that the new vehicle, including all parts of its emission control system, meets two conditions:

(1) It is designed, built, and equipped so it conforms at the time of sale to the ultimate purchaser with the requirements of this part.

(2) It is free from defects in materials and workmanship that cause the vehicle to fail to conform to the requirements of this part during the applicable warranty period.

(b) *Warranty period.* (1) Your emission-related warranty must be valid for at least:

(i) 5 years or 50,000 miles for spark-ignition vehicles and Class 5 and lighter heavy-duty vehicles (except tires).

(ii) 5 years or 100,000 miles for Class 6 through Class 8 heavy-duty vehicles (except tires).

(iii) 5 years for trailers (except tires).

(iv) 1 year for tires installed on trailers, and 2 years or 24,000 miles for all other tires.

(2) You may offer an emission-related warranty more generous than we require. The emission-related warranty for the vehicle may not be shorter than any basic mechanical warranty you provide to that owner without charge for the vehicle. Similarly, the emission-related warranty for any component may not be shorter than any warranty you provide to that owner without charge for that component. This means that your warranty for a given vehicle may not treat emission-related and nonemission-related defects differently for any component. The warranty period begins when the vehicle is placed into service.

(c) *Components covered.* The emission-related warranty covers tires, automatic tire inflation systems, vehicle speed limiters, idle shutdown systems, hybrid system components, and devices added to the vehicle to improve aerodynamic performance (not including standard components such as hoods or mirrors even if they have been optimized for aerodynamics), to the extent such emission-related components are included in your application for certification. The emission-related warranty also covers other added emission-related components to the extent they are included in your application for certification. The emission-related warranty covers all components whose failure would increase a vehicle's emissions of air conditioning refrigerants (for vehicles subject to air conditioning leakage standards), and it covers all components whose failure would increase a vehicle's evaporative emissions (for vehicles subject to evaporative emission standards). The emission-related warranty covers these components even if another company produces the component. Your emission-related warranty does not need to cover components whose failure would not increase a vehicle's emissions of any regulated pollutant.

(d) *Limited applicability.* You may deny warranty claims under this section if the operator caused the problem through improper maintenance or use, as described in 40 CFR 1068.115.

(e) *Owners manual.* Describe in the owners manual the emission-related warranty provisions from this section that apply to the vehicle.

§ 1037.125 Maintenance instructions and allowable maintenance.

Give the ultimate purchaser of each new vehicle written instructions for properly maintaining and using the vehicle, including the emission control system. The maintenance instructions also apply to service accumulation on any of your emission-data vehicles. See paragraph (i) of this section for requirements related to tire replacement. Only the provisions of paragraph (h) of this section apply for trailers.

(a) *Critical emission-related maintenance.* Critical emission-related maintenance includes any adjustment, cleaning, repair, or replacement of critical emission-related components. This may also include additional emission-related maintenance that you determine is critical if we approve it in advance. You may schedule critical emission-related maintenance on these components if you demonstrate that the maintenance is reasonably likely to be done at the recommended intervals on in-use vehicles. We will accept scheduled maintenance as reasonably likely to occur if you satisfy any of the following conditions:

(1) You present data showing that, if a lack of maintenance increases emissions, it also unacceptably degrades the vehicle's performance.

(2) You present survey data showing that at least 80 percent of vehicles in the field get the maintenance you specify at the recommended intervals.

(3) You provide the maintenance free of charge and clearly say so in your maintenance instructions.

(4) You otherwise show us that the maintenance is reasonably likely to be done at the recommended intervals.

(b) *Recommended additional maintenance.* You may recommend any additional amount of maintenance on the components listed in paragraph (a) of this section, as long as you state clearly that these maintenance steps are not necessary to keep the emission-related warranty valid. If operators do the maintenance specified in paragraph (a) of this section, but not the recommended additional maintenance, this does not allow you to disqualify those vehicles from in-use testing or deny a warranty claim. Do not take these maintenance steps during service accumulation on your emission-data vehicles.

(c) *Special maintenance.* You may specify more frequent maintenance to address problems related to special situations, such as atypical vehicle operation. You must clearly state that this additional maintenance is associated with the special situation you are addressing. We may disapprove your maintenance instructions if we determine that you have specified special maintenance steps to address vehicle operation that is not atypical, or that the maintenance is unlikely to occur in use. If we determine that certain maintenance items do not qualify as special maintenance under this paragraph (c), you may identify this as recommended additional maintenance under paragraph (b) of this section.

(d) *Noncritical emission-related maintenance.* Subject to the provisions of this paragraph (d), you may schedule any amount of emission-related inspection or maintenance that is not covered by paragraph (a) of this section (that is, maintenance that is neither explicitly identified as critical emission-related maintenance, nor that we approve as critical emission-related maintenance). Noncritical emission-related maintenance generally includes maintenance on the components we specify in 40 CFR part 1068, Appendix I, that is not covered in paragraph (a) of this section. You must state in the owners manual that these steps are not necessary to keep the emission-related warranty valid. If operators fail to do this maintenance, this does not allow you to disqualify those vehicles from in-use testing or deny a warranty claim. Do not take these inspection or maintenance steps during service accumulation on your emission-data vehicles.

(e) *Maintenance that is not emission-related.* For maintenance unrelated to emission controls, you may schedule any amount of inspection or maintenance. You may also take these inspection or maintenance steps during service accumulation on your emission-data vehicles, as long as they are reasonable and technologically necessary. You may perform this nonemission-related maintenance on emission-data vehicles at the least frequent intervals that you recommend to the ultimate purchaser (but not the intervals recommended for severe service).

(f) *Source of parts and repairs.* State clearly on the first page of your written maintenance instructions that a repair shop or person of the owner's choosing may maintain, replace, or repair emission control devices and systems. Your instructions may not require components or service identified by brand, trade, or corporate name. Also, do not directly or indirectly condition your warranty on a requirement that the vehicle be serviced by your franchised dealers or any other service establishments with which you have a commercial relationship. You may disregard the requirements in this paragraph (f) if you do one of two things:

(1) Provide a component or service without charge under the purchase agreement.

(2) Get us to waive this prohibition in the public's interest by convincing us the vehicle will work properly only with the identified component or service.

(g) [Reserved]

(h) *Owners manual.* Explain the owner's responsibility for proper maintenance in the owners manual.

(i) *Tire maintenance and replacement.* Include instructions that will enable the owner to replace tires so that the vehicle conforms to the original certified vehicle configuration.

§ 1037.130 Assembly instructions for secondary vehicle manufacturers.

(a) If you sell a certified incomplete vehicle to a secondary vehicle manufacturer, give the secondary vehicle manufacturer instructions for completing vehicle assembly consistent with the requirements of this part. Include all information necessary to ensure that the final vehicle assembly an engine will be in its certified configuration.

(b) Make sure these instructions have the following information:

(1) Include the heading: ''Emission-related installation instructions''.

(2) State: ''Failing to follow these instructions when completing assembly of a heavy-duty motor vehicle violates federal law, subject to fines or other penalties as described in the Clean Air Act.''

(3) Describe the necessary steps for installing any diagnostic system required under 40 CFR part 86.

(4) Describe how your certification is limited for any type of application, as illustrated in the following examples:

(i) If the incomplete vehicle is at or below 8,500 pounds GVWR, state that the vehicle's certification is valid under this part 1037 only if the final configuration has a vehicle curb weight above 6,000 pounds or basic vehicle frontal area above 45 square feet.

(ii) If your engine will be installed in a vehicle that you certify to meet diurnal emission standards using an evaporative canister, but you do not install the fuel tank, identify the maximum permissible fuel tank capacity if tank size affects compliance.

(5) Describe any other instructions to make sure the vehicle will operate according to design specifications in your application for certification.

(c) Provide instructions in writing or in an equivalent format. You may include this information with the incomplete vehicle document required by DOT. If you do not provide the instructions in writing, explain in your application for certification how you will ensure that each installer is informed of the installation requirements.

§ 1037.135 Labeling.

(a) Assign each vehicle a unique identification number and permanently affix, engrave, or stamp it on the vehicle in a legible way. The vehicle identification number (VIN) serves this purpose.

(b) At the time of manufacture, affix a permanent and legible label identifying each vehicle. The label must be—

(1) Attached in one piece so it is not removable without being destroyed or defaced.

(2) Secured to a part of the vehicle needed for normal operation and not normally requiring replacement.

(3) Durable and readable for the vehicle's entire life.

(4) Written in English.

(c) The label must—

(1) Include the heading ''VEHICLE EMISSION CONTROL INFORMATION''.

(2) Include your full corporate name and trademark. You may identify another company and use its trademark instead of yours if you comply with the branding provisions of 40 CFR 1068.45.

(3) Include EPA's standardized designation for the vehicle family.

(4) State the regulatory subcategory that determines the applicable emission standards for the vehicle family (see definition in § 1037.801).

(5) State the date of manufacture [DAY (optional), MONTH, and YEAR]. You may omit this from the label if you stamp, engrave, or otherwise permanently identify it elsewhere on the vehicle, in which case you must also describe in your application for certification where you will identify the date on the vehicle.

(6) Identify the emission control system. Use terms and abbreviations as described in Appendix III to this part or other applicable conventions. Phase 2 tractors and Phase 2 vocational vehicles (other than those certified to standards for emergency vehicles) may omit this information.

(7) Identify any requirements for fuel and lubricants that do not involve fuel-sulfur levels.

(8) State: ''THIS VEHICLE COMPLIES WITH U.S. EPA REGULATIONS FOR [MODEL YEAR] HEAVY-DUTY VEHICLES.''

(9) If you rely on another company to design and install fuel tanks in incomplete vehicles that use an evaporative canister for controlling diurnal emissions, include the following statement: ''THIS VEHICLE IS DESIGNED TO COMPLY WITH EVAPORATIVE EMISSION STANDARDS WITH UP TO × GALLONS OF FUEL TANK CAPACITY.'' Complete this statement by identifying the maximum specified fuel tank capacity associated with your certification.

(d) You may add information to the emission control information label to identify other emission standards that the vehicle meets or does not meet (such as European standards). You may also add other information to ensure that the vehicle will be properly maintained and used.

(e) You may ask us to approve modified labeling requirements in this part 1037 if you show that it is necessary or appropriate. We will approve your request if your alternate label is consistent with the requirements of this part.

§ 1037.140 Determining vehicle parameters.

(a) Where applicable, a vehicle's roof height and a trailer's length are determined from nominal design specifications, as provided in this section. Specify design values for roof height and trailer length to the nearest inch.

(b) Base roof height on fully inflated tires having a static loaded radius equal to the arithmetic mean of the largest and smallest static loaded radius of tires you offer or a standard tire we approve.

(c) Base trailer length on the outer dimensions of the load-carrying structure. Do not include aerodynamic devices or HVAC units.

(d) The nominal design specifications must be within the range of the actual values from production vehicles considering normal production variability. In the case of roof height, use the mean tire radius specified in paragraph (b) of this section. If after production begins it is determined that your nominal design specifications do not represent production vehicles, we may require you to amend your application for certification under § 1037.225.

(e) If your vehicle is equipped with an adjustable roof fairing, measure the roof height with the fairing in its lowest setting.

(f) For any provisions in this part that depend on the number of axles on a vehicle, include lift axles or any other installed axles that can be used to carry the vehicle's weight while in motion.

§ 1037.150 Interim provisions.

The provisions in this section apply instead of other provisions in this part.

(a) *Incentives for early introduction.* The provisions of this paragraph (a) apply with respect to vehicles produced in model years before 2014 Manufacturers may voluntarily certify in model year 2013 (or earlier model years for electric vehicles) to the greenhouse gas standards of this part.

(1) This paragraph (a)(1) applies for regulatory subcategories subject to the standards of § 1037.105 or § 1037.106. Except as specified in paragraph (a)(3) of this section, to generate early credits under this paragraph for any vehicles other than electric vehicles, you must certify your entire U.S.-directed production volume within the regulatory subcategory to these standards. Except as specified in paragraph (a)(4) of this section, if some vehicle families within a regulatory subcategory are certified after the start of the model year, you may generate credits only for production that occurs after all families are certified. For example, if you produce three vehicle families in an averaging set and you receive your certificates for those families on January 4, 2013, March 15, 2013, and April 24, 2013, you may not generate credits for model year 2013 production in any of the families that occurs before April 24, 2013. Calculate credits relative to the standard that would apply in model year 2014 using the equations in subpart H of this part. You may bank credits equal to the surplus credits you generate under this paragraph (a) multiplied by 1.50. For example, if you have 1.0 Mg of surplus credits for model year 2013, you may bank 1.5 Mg of credits. Credit deficits for an averaging set prior to model year 2014 do not carry over to model year 2014. These credits may be used to show compliance with the standards of this part for 2014 and later model years. We recommend that you notify EPA of your intent to use this provision before submitting your applications.

(2) [Reserved]

(3) You may generate emission credits for the number of additional SmartWay designated tractors (relative to your 2012 production), provided you do not generate credits for those vehicles under paragraph (a)(1) of this section. Calculate credits for each regulatory subcategory relative to the standard that would apply in model year 2014 using the equations in subpart H of this part. Use a production volume equal to the number of designated model year 2013 SmartWay tractors minus the number of designated model year 2012 SmartWay tractors. You may bank credits equal to the surplus credits you generate under this paragraph (a)(3) multiplied by 1.50. Your 2012 and 2013 model years must be equivalent in length.

(4) This paragraph (a)(4) applies where you do not receive your final certificate in a regulatory subcategory within 30 days of submitting your final application for that subcategory. Calculate your credits for all production that occurs 30 days or more after you

submit your final application for the subcategory.

(b) *Interim standards for pickups and vans.* See 40 CFR part 86, subpart S, for interim standards that apply for certain heavy-duty pickups and vans.

(c) *Provisions for small manufacturers.* Standards apply on a delayed schedule for manufacturers meeting the small business criteria specified in 13 CFR 121.201. Apply the small business criteria for NAICS code 336120 for vocational vehicles and tractors and 336212 for trailers. Qualifying manufacturers are not subject to the greenhouse gas standards of §§ 1037.105 and 1037.106 for vehicles built before January 1, 2022, Similarly, qualifying manufacturers are not subject to the greenhouse gas standards of § 1037.107 for trailers built before January 1, 2019. In addition, qualifying manufacturers producing vehicles that run on any fuel other than gasoline, E85, or diesel fuel may delay complying with every new standard under this part by one model year. Qualifying manufacturers must notify the Designated Compliance Officer each model year before introducing these excluded vehicles into U.S. commerce. This notification must include a description of the manufacturer's qualification as a small business under 13 CFR 121.201. You must label your excluded vehicles with the following statement: ''THIS VEHICLE IS EXCLUDED UNDER 40 CFR 1037.150(c).'' Small businesses may certify their vehicles under this part 1037 before standards start to apply; however, they may generate emission credits only if they certify their entire U.S.-directed production volume within the applicable averaging set for that model year.

(d) *Air conditioning leakage for vocational vehicles.* The air conditioning leakage standard of § 1037.115 does not apply for model year 2020 and earlier vocational vehicles.

(e) [Reserved]

(f) *Electric vehicles.* All electric vehicles are deemed to have zero emissions of CO_2, CH_4, and N_2O. No emission testing is required for electric vehicles. Use good engineering judgment to apply other requirements of this part to electric vehicles.

(g) *Compliance date.* Compliance with the standards of this part was optional prior to January 1, 2014. This means that if your 2014 model year begins before January 1, 2014, you may certify for a partial model year that begins on January 1, 2014 and ends on the day your model year would normally end. You must label model year 2014 vehicles excluded under this paragraph (g) with the following statement: ''THIS VEHICLE IS EXCLUDED UNDER 40 CFR 1037.150(g).''

(h) *Off-road vehicle exemption.* In unusual circumstances, vehicle manufacturers may ask us to exempt vehicles under § 1037.631 based on other criteria that are equivalent to those specified in § 1037.631(a). For example, we would normally not grant relief in cases where the vehicle manufacturer had credits or could otherwise comply with applicable standards. Request approval for the exemption before you produce the subject vehicles. Send your request with supporting information to the Designated Compliance Officer; we will coordinate with NHTSA in making a determination under § 1037.210. If you introduce into U.S. commerce vehicles that depend on our approval under this paragraph (h) before we inform you of our approval, those vehicles violate 40 CFR 1068.101(a)(1).

(i) *Credit multiplier for advanced technology.* If you generate credits from model year 2020 and earlier vehicles certified with advanced technology, you may multiply these credits by 1.50, except that you may not apply this multiplier in addition to the early-credit multiplier of paragraph (a) of this section.

(j) *Limited prohibition related to early model year engines.* The provisions of this paragraph (j) apply only for vehicles that have a date of manufacture before January 1, 2018. See § 1037.635 for related provisions that apply in later model years. The prohibition in § 1037.601 against introducing into U.S. commerce a vehicle containing an engine not certified to the standards applicable for the calendar year of installation does not apply for vehicles using model year 2014 or 2015 spark-ignition engines, or any model year 2013 or earlier engines.

(k) *Verifying drag areas from in-use vehicles.* This paragraph (k) applies instead of § 1037.401(b) through model year 2020. We may measure the drag area of your vehicles after they have been placed into service. To account for measurement variability, your vehicle is deemed to conform to the regulations of this part with respect to aerodynamic performance if we measure its drag area to be at or below the maximum drag area allowed for the bin above the bin to which you certified (for example, Bin II if you certified the vehicle to Bin III), unless we determine that you knowingly produced the vehicle to have a higher drag area than is allowed for the bin to which it was certified.

(l) *Optional sister-vehicle certification under 40 CFR part 86.* You may certify certain complete or cab-complete vehicles to the GHG standards of 40 CFR 86.1819 instead of the standards of § 1037.105 as specified in 40 CFR 86.1819–14(j).

(m) *Loose engine sales.* Manufacturers may certify certain model year 2020 and earlier spark-ignition engines to emission standards under 40 CFR 1036.108 where they are identical to engines used in vehicles certified to the standards of 40 CFR 86.1819. Vehicles in which those engines are installed are subject to standards under this part as specified in § 1037.105. See 40 CFR 86.1819–14(k)(8).

(n) *Streamlined preliminary approval for trailer devices.* Before January 1, 2018, manufacturers of aerodynamic devices for trailers may ask for preliminary EPA approval of compliance data for their devices based on qualifying for designation under the SmartWay program based on measured C_DA values, whether or not that involves testing or other methods specified in § 1037.525. Trailer manufacturers may certify based on delta C_DA values established under this paragraph (n) through model year 2020. Manufacturers must perform testing as specified in subpart F of this part for any vehicles or aerodynamic devices not qualifying for approval under this paragraph (n).

(o) *Phase 1 coastdown procedures.* For tractors subject to Phase 1 standards under § 1037.106, the default method for measuring drag area (C_DA) is the coastdown procedure specified in 40 CFR part 1066, subpart D. This includes preparing the tractor and the standard trailer with wheels meeting specifications of § 1037.527(b) and submitting information related to your coastdown testing under § 1037.527(h).

(p) *ABT reports.* Through model year 2017, you may submit a final report under § 1037.730 up to 270 days after the end of the model year, as long as you send a draft report with the same information within 90 days after the end of the model year.

(q) *Vehicle families for advanced and off-cycle technologies.* For vocational vehicles and tractors subject to Phase 1 standards, create separate vehicle families for vehicles that contain advanced or off-cycle technologies; group those vehicles together in a vehicle family if they use the same advanced or off-cycle technologies.

(r) *Limited carryover from Phase 1 to Phase 2.* The provisions for carryover data in § 1037.235(d) do not allow you to use aerodynamic test results from Phase 1 to support a compliance demonstration for Phase 2 certification.

(s) *Interim useful life for light heavy-duty vocational vehicles.* Class 2b through Class 5 vocational vehicles certified to Phase 1 standards are subject to a useful life of 110,000 miles or 10 years, whichever comes first, instead of the useful life specified in § 1037.105. For emission credits generated from these Phase 1 vehicles, multiply any banked credits that you carry forward to demonstrate compliance with Phase 2 standards by 1.36.

Subpart C—Certifying Vehicle Families

§ 1037.201 General requirements for obtaining a certificate of conformity.

(a) You must send us a separate application for a certificate of conformity for each vehicle family. A certificate of conformity is valid from the indicated effective date until the end of the model year for which it is issued, which may not extend beyond December 31 of that year. You must renew your certification annually for any vehicles you continue to produce.

(b) The application must contain all the information required by this part and must not include false or incomplete statements or information (see § 1037.255).

(c) We may ask you to include less information than we specify in this subpart, as long as you maintain all the information required by § 1037.250.

(d) You must use good engineering judgment for all decisions related to your application (see 40 CFR 1068.5).

(e) An authorized representative of your company must approve and sign the application.

(f) See § 1037.255 for provisions describing how we will process your application.

(g) We may perform confirmatory testing on your vehicles; for example, we may test vehicles to verify drag areas or other GEM inputs. This includes tractors used to determine $F_{\text{alt-aero}}$ under § 1037.525. We may require you to deliver your test vehicles or components to a facility we designate for our testing. Alternatively, you may choose to deliver another vehicle or component that is identical in all material respects to the test vehicle or component, or a different vehicle or component that we determine can appropriately serve as an emission-data vehicle for the family. We may perform confirmatory testing on engines under 40 CFR part 1036 and may require you to apply modified fuel maps from that testing for certification under this part.

(h) The certification and testing provisions of 40 CFR part 86, subpart S, apply instead of the provisions of this subpart relative to the evaporative and refueling emission standards specified in § 1037.103, except that § 1037.245 describes how to demonstrate compliance with evaporative emission standards.

(i) Vehicles and installed engines must meet exhaust, evaporative, and refueling emission standards and certification requirements in 40 CFR part 86 or 40 CFR part 1036, as applicable. Include the information described in 40 CFR part 86, subpart S, or 40 CFR 1036.205 in your application for certification in addition to what we specify in § 1037.205 so we can issue a single certificate of conformity for all the requirements that apply for your vehicle and the installed engine.

§ 1037.205 What must I include in my application?

This section specifies the information that must be in your application, unless we ask you to include less information under § 1037.201(c). We may require you to provide additional information to evaluate your application. References to testing and emission-data vehicles refer to testing vehicles or components to measure any quantity that serves as an input value for modeling emission rates under § 1037.515 or 1037.520.

(a) Describe the vehicle family's specifications and other basic parameters of the vehicle's design and emission controls. List the fuel type on which your vocational vehicles and tractors are designed to operate (for example, ultra low-sulfur diesel fuel).

(b) Explain how the emission control system operates. As applicable, describe in detail all system components for controlling greenhouse gas emissions, including all auxiliary emission control devices (AECDs) and all fuel-system components you will install on any production vehicle. Identify the part number of each component you describe. For this paragraph (b), treat as separate AECDs any devices that modulate or activate differently from each other. Also describe your modeling inputs as described in §§ 1037.515 and 1037.520, with the following additional information if it applies for your vehicles:

(1) Describe your design for vehicle speed limiters, consistent with § 1037.640.

(2) Describe your design for predictive cruise control.

(3) Describe your design for automatic engine shutdown systems, consistent with § 1037.660.

(4) Describe your engineering analysis demonstrating that your air conditioning compressor qualifies as a high-efficiency model as described in 40 CFR 86.1868–12(h)(5).

(5) Describe your design for stop-start technology, including the logic for engine shutdown and the maximum duration of engine operation after the onset of any vehicle conditions described in § 1037.520(f)(8)(iii).

(6) If you perform powertrain testing under § 1037.550, report both CO_2 and NO_X emission levels corresponding to each test run.

(7) Include measurements for vehicles with hybrid power take-off systems.

(c) For vehicles subject to air conditioning standards, include:

(1) The refrigerant leakage rates (leak scores).

(2) The type of refrigerant and the refrigerant capacity of the air conditioning systems.

(3) The corporate name of the final installer of the air conditioning system.

(d) Describe any vehicles you selected for testing and the reasons for selecting them.

(e) Describe any test equipment and procedures that you used, including any special or alternate test procedures you used (see § 1037.501). Include information describing the procedures you used to determine C_DA values for tractors and trailers as specified in § 1037.525.

(f) Describe how you operated any emission-data vehicle before testing, including the duty cycle and the number of vehicle operating miles used to stabilize emission-related performance. Explain why you selected the method of service accumulation. Describe any scheduled maintenance you did.

(g) Where applicable, list the specifications of any test fuel to show that it falls within the required ranges we specify in 40 CFR part 1065.

(h) Identify the vehicle family's useful life.

(i) Include the maintenance instructions and warranty statement you will give to the ultimate purchaser of each new vehicle (see §§ 1037.120 and 1037.125).

(j) Describe your emission control information label (see § 1037.135).

(k) Identify the emission standards or FELs to which you are certifying vehicles in the vehicle family. For families containing multiple subfamilies, this means that you must identify multiple CO_2 FELs. For example, you may identify the highest and lowest FELs to which any of your subfamilies will be certified and also list all possible FELs in between (which will be in 1 g/ton-mile increments).

(l) Where applicable, identify the vehicle family's deterioration factors and describe how you developed them.

Present any emission test data you used for this (see § 1037.241(c)).

(m) Where applicable, state that you operated your emission-data vehicles as described in the application (including the test procedures, test parameters, and test fuels) to show you meet the requirements of this part.

(n) [Reserved]

(o) Report calculated and modeled emission results as follows:

(1) For vocational vehicles and tractors, report modeling results for ten configurations. Include modeling inputs and detailed descriptions of how they were derived. Unless we specify otherwise, include the configuration with the highest modeling result, the lowest modeling result, and the configurations with the highest projected sales.

(2) For trailers that demonstrate compliance with g/ton-mile emission standards as described in § 1037.515, report CO_2 emission results for the configurations with the highest and lowest calculated values, and for the configuration with the highest projected sales.

(p) Where applicable, describe all adjustable operating parameters (see § 1037.115), including production tolerances. You do not need to include parameters that do not affect emissions covered by your application. Include the following in your description of each parameter:

(1) The nominal or recommended setting.

(2) The intended physically adjustable range.

(3) The limits or stops used to establish adjustable ranges.

(4) Information showing why the limits, stops, or other means of inhibiting adjustment are effective in preventing adjustment of parameters on in-use vehicles to settings outside your intended physically adjustable ranges.

(q) [Reserved]

(r) Unconditionally certify that all the vehicles in the vehicle family comply with the requirements of this part, other referenced parts of the CFR, and the Clean Air Act.

(s) Include good-faith estimates of U.S.-directed production volumes by subfamily. We may require you to describe the basis of your estimates.

(t) Include the information required by other subparts of this part. For example, include the information required by § 1037.725 if you plan to generate or use emission credits.

(u) Include other applicable information, such as information specified in this part or 40 CFR part 1068 related to requests for exemptions.

(v) Name an agent for service located in the United States. Service on this agent constitutes service on you or any of your officers or employees for any action by EPA or otherwise by the United States related to the requirements of this part.

§ 1037.210 Preliminary approval before certification.

If you send us information before you finish the application, we may review it and make any appropriate determinations. Decisions made under this section are considered to be preliminary approval, subject to final review and approval. We will generally not reverse a decision where we have given you preliminary approval, unless we find new information supporting a different decision. If you request preliminary approval related to the upcoming model year or the model year after that, we will make best-efforts to make the appropriate determinations as soon as practicable. We will generally not provide preliminary approval related to a future model year more than two years ahead of time.

§ 1037.211 Preliminary approval for manufacturers of aerodynamic devices.

(a) If you design or manufacture aerodynamic devices for trailers, you may ask us to provide preliminary approval for the measured performance of your devices. While decisions made under this section are considered to be preliminary approval, we will not reverse a decision where we have given you preliminary approval, unless we find new information supporting a different decision. For example, where we measure the performance of your device after giving you preliminary approval and its measured performance is less than your data indicated, we may rescind the preliminary approval of your test results.

(b) To request this, you must provide test data for delta C_DA values as specified in § 1037.150(n) or § 1037.525. Trailer manufacturers may use approved delta C_DA values as inputs under § 1037.515 to support their application for certification.

(c) The following provisions apply for combining multiple devices under this section for the purpose of certifying trailers:

(1) If the device manufacturer establishes a delta C_DA value in a single test with multiple aerodynamic devices installed, trailer manufacturers may use that delta C_DA value directly for the same combination of aerodynamic devices installed on production trailers.

(2) Trailer manufacturers may combine delta C_DA values for aerodynamic devices that are not tested together, as long as each device does not significantly impair the effectiveness of another, consistent with good engineering judgment. To approximate the overall benefit of multiple devices, calculate a composite delta C_DA value for multiple aerodynamic devices by applying the full delta C_DA value for the device with the greatest aerodynamic improvement, adding the second-highest delta C_DA value multiplied by 0.9, and adding any other delta C_DA values multiplied by 0.8.

§ 1037.220 Amending maintenance instructions.

You may amend your emission-related maintenance instructions after you submit your application for certification as long as the amended instructions remain consistent with the provisions of § 1037.125. You must send the Designated Compliance Officer a written request to amend your application for certification for a vehicle family if you want to change the emission-related maintenance instructions in a way that could affect emissions. In your request, describe the proposed changes to the maintenance instructions. If operators follow the original maintenance instructions rather than the newly specified maintenance, this does not allow you to disqualify those vehicles from in-use testing or deny a warranty claim.

(a) If you are decreasing or eliminating any specified maintenance, you may distribute the new maintenance instructions to your customers 30 days after we receive your request, unless we disapprove your request. This would generally include replacing one maintenance step with another. We may approve a shorter time or waive this requirement.

(b) If your requested change would not decrease the specified maintenance, you may distribute the new maintenance instructions anytime after you send your request. For example, this paragraph (b) would cover adding instructions to increase the frequency of filter changes for vehicles in severe-duty applications.

(c) You need not request approval if you are making only minor corrections (such as correcting typographical mistakes), clarifying your maintenance instructions, or changing instructions for maintenance unrelated to emission control. We may ask you to send us copies of maintenance instructions revised under this paragraph (c).

§ 1037.225 Amending applications for certification.

Before we issue you a certificate of conformity, you may amend your application to include new or modified vehicle configurations, subject to the provisions of this section. After we have issued your certificate of conformity, but before the end of the model year, you may send us an amended application requesting that we include new or modified vehicle configurations within the scope of the certificate, subject to the provisions of this section. Before the end of the model year, you must amend your application if any changes occur with respect to any information that is included or should be included in your application. After the end of the model year, you may amend your application only to update maintenance instructions as described in § 1037.220 or to modify an FEL as described in paragraph (f) of this section.

(a) You must amend your application before you take any of the following actions:

(1) Add a vehicle configuration to a vehicle family. In this case, the vehicle configuration added must be consistent with other vehicle configurations in the vehicle family with respect to the criteria listed in § 1037.230.

(2) Change a vehicle configuration already included in a vehicle family in a way that may affect emissions, or change any of the components you described in your application for certification. This includes production and design changes that may affect emissions any time during the vehicle's lifetime.

(3) Modify an FEL for a vehicle family as described in paragraph (f) of this section.

(b) To amend your application for certification, send the relevant information to the Designated Compliance Officer.

(1) Describe in detail the addition or change in the vehicle model or configuration you intend to make.

(2) Include engineering evaluations or data showing that the amended vehicle family complies with all applicable requirements. You may do this by showing that the original emission-data vehicle is still appropriate for showing that the amended family complies with all applicable requirements.

(3) If the original emission-data vehicle or emission modeling for the vehicle family is not appropriate to show compliance for the new or modified vehicle configuration, include new test data or emission modeling showing that the new or modified vehicle configuration meets the requirements of this part.

(4) Include any other information needed to make your application correct and complete.

(c) We may ask for more test data or engineering evaluations. You must give us these within 30 days after we request them.

(d) For vehicle families already covered by a certificate of conformity, we will determine whether the existing certificate of conformity covers your newly added or modified vehicle. You may ask for a hearing if we deny your request (see § 1037.820).

(e) For vehicle families already covered by a certificate of conformity, you may start producing the new or modified vehicle configuration anytime after you send us your amended application and before we make a decision under paragraph (d) of this section. However, if we determine that the affected vehicles do not meet applicable requirements, we will notify you to cease production of the vehicles and may require you to recall the vehicles at no expense to the owner. Choosing to produce vehicles under this paragraph (e) is deemed to be consent to recall all vehicles that we determine do not meet applicable emission standards or other requirements and to remedy the nonconformity at no expense to the owner. If you do not provide information required under paragraph (c) of this section within 30 days after we request it, you must stop producing the new or modified vehicles.

(f) You may ask us to approve a change to your FEL in certain cases after the start of production. The changed FEL may not apply to vehicles you have already introduced into U.S. commerce, except as described in this paragraph (f). You may ask us to approve a change to your FEL in the following cases:

(1) You may ask to raise your FEL for your vehicle subfamily at any time. In your request, you must show that you will still be able to meet the emission standards as specified in subparts B and H of this part. Use the appropriate FELs with corresponding production volumes to calculate emission credits for the model year, as described in subpart H of this part.

(2) Where testing applies, you may ask to lower the FEL for your vehicle subfamily only if you have test data from production vehicles showing that emissions are below the proposed lower FEL. Otherwise, you may ask to lower your FEL for your vehicle subfamily at any time. The lower FEL applies only to vehicles you produce after we approve the new FEL. Use the appropriate FELs with corresponding production volumes to calculate emission credits for the model year, as described in subpart H of this part.

(3) You may ask to add an FEL for your vehicle family at any time.

§ 1037.230 Vehicle families, sub-families, and configurations.

(a) For purposes of certifying your vehicles to greenhouse gas standards, divide your product line into families of vehicles based on regulatory subcategories as specified in this section. Subcategories are specified using terms defined in § 1037.801. Your vehicle family is limited to a single model year.

(1) Apply subcategories for vocational vehicles and vocational tractors as shown in Table 1 of this section. This involves 21 separate subcategories for Phase 2 vehicles to account for engine type, GVWR, and the vehicle characteristics corresponding to the duty cycles for vocational vehicles as specified in § 1037.510; three separate subcategories apply for emergency vehicles as described in § 1037.105(b)(4). Divide Phase 1 vehicles into three GVWR-based vehicle classes as shown in Table 1 of this section, disregarding additional specified characteristics. Table 1 follows:

TABLE 1 OF § 1037.230—VOCATIONAL VEHICLE SUBCATEGORIES

Engine type	Class 2b–5	Class 6–7	Class 8
Compression-ignition	Urban	Urban	Urban.
	Multi-Purpose	Multi-Purpose	Multi-Purpose.
	Regional	Regional	Regional.
Spark-ignition	Urban	Urban	Urban.
	Multi-Purpose	Multi-Purpose	Multi-Purpose.
	Regional	Regional	Regional.
All	Emergency	Emergency	Emergency.

(2) Apply subcategories for tractors (other than vocational tractors) as shown in the following table:

TABLE 2 OF § 1037.230—TRACTOR SUBCATEGORIES

Class 7	Class 8	
Low-roof tractors	Low-roof day cabs	Low-roof sleeper cabs.
Mid-roof tractors	Mid-roof day cabs	Mid-roof sleeper cabs.
High-roof tractors	High-roof day cabs	High-roof sleeper cabs.
	Heavy-haul tractors (starting with Phase 2)	

(3) Apply subcategories for trailers as shown in the following table:

TABLE 3 OF § 1037.230— TRAILER SUBCATEGORIES

Full-aero trailers	Partial-aero trailers [a]	Other trailers
Long dry box vans	Long dry box vans	Non-aero trailers.
Short dry box vans	Short dry box vans	Non-box trailers.
Long refrigerated box vans	Long refrigerated box vans	
Short refrigerated box vans	Short refrigerated box vans	

[a] The partial-aero subcategories do not apply before model year 2027.

(b) If the vehicles in your family are being certified to more than one FEL, subdivide your greenhouse gas vehicle families into subfamilies that include vehicles with identical FELs. Note that you may add subfamilies at any time during the model year.

(c) Group vehicles into configurations consistent with the definition of ''vehicle configuration'' in § 1037.801. Note that vehicles with hardware or software differences that are related to measured or modeled emissions are considered to be different vehicle configurations even if they have the same modeling inputs and FEL. Note also, that you are not required to separately identify all configurations for certification. See paragraph (g) of this section for provisions allowing you to group certain hardware differences into the same configuration. Note that you are not required to identify all possible configurations for certification; also, you are required to include in your final report only those configurations you produced.

(d) You may combine dissimilar vehicles into a single vehicle family in special circumstances as follows:

(1) For a vehicle model that includes a range of GVWR values that straddle weight classes, you may include all the vehicles in the same vehicle family if you certify the vehicle family to the numerically lower CO_2 emission standard from the affected weight classes. Vehicles that are optionally certified to a more stringent under this paragraph (d)(1) are subject to useful-life and all other provisions corresponding to the weight class with the numerically lower CO_2 emission standard.

(2) You may include refrigerated box vans in a vehicle family with dry box vans; if you do this, all the trailers in the family are subject to the standards that apply for dry box vans. Similarly, you may include short trailers in a vehicle family with long trailers; if you do this, all the trailers in the family are subject to the standards that apply for long vans. You may also include short refrigerated box vans in a vehicle family with long dry box vans; if you do this, all the trailers in the family are subject to the standards that apply for long dry box vans.

(e) You may divide your families into more families than specified in this section.

(f) You may ask us to allow you to group into the same configuration vehicles that have very small body hardware differences that do not significantly affect drag areas. Note that this allowance does not apply for substantial differences, even if the vehicles have the same measured drag areas.

§ 1037.231 Powertrain families.

(a) If you choose to perform powertrain testing as specified in § 1037.550, use good engineering judgment to divide your product line into powertrain families that are expected to have similar fuel consumptions and CO_2 emission characteristics throughout the useful life. Your powertrain family is limited to a single model year.

(b) Except as specified in paragraph (c) of this section, group powertrains in the same powertrain family if they share all the following attributes:

(1) Engine family.

(2) The applicable simulated test vehicle category according to § 1037.550(f): Either Class 2b through 7, heavy-haul or Class 8 other than heavy-haul.

(3) Number of clutches.

(4) Type of clutch (*e.g.,* wet or dry).

(5) Presence and location of a fluid coupling such as a torque converter.

(6) Gear configuration, as follows:

(i) Planetary (*e.g.,* simple, compound, meshed-planet, stepped-planet, multi-stage).

(ii) Countershaft (*e.g.,* single, double, triple).

(iii) Continuously variable (*e.g.,* pulley, magnetic, torroidal).

(7) Number of available forward gears, and transmission gear ratio for each available forward gear, if applicable.

(8) Transmission oil sump configuration (*e.g.,* conventional or dry).

(9) The power transfer configuration of any hybrid technology (*e.g.,* series or parallel).

(10) The energy storage device and capacity of any hybrid technology (*e.g.,* 10 MJ hydraulic accumulator, 10 kW·hr Lithium-ion battery pack, 10 MJ ultracapacitor bank).

(11) The rated output of any hybrid mechanical power technology (*e.g.,* 50 kW electric motor).

(c) For powertrains that share all the attributes described in paragraph (b) of this section, divide them further into separate powertrain families based on common calibration attributes. Group powertrains in the same powertrain family to the extent that powertrain test results and corresponding emission levels are expected to be similar throughout the useful life.

(d) You may subdivide a group of powertrains with shared attributes under paragraph (b) of this section into different powertrain families.

(e) In unusual circumstances, you may group powertrains into the same powertrain family even if they do not have shared attributes under in paragraph (b) of this section if you show that their emission characteristics throughout the useful life will be similar.

(f) If you include the axle when performing powertrain testing for the family, you must limit the family to include only those axles represented by the test results. You may include multiple axle ratios in the family if you test with the axle expected to produce the highest emission results.

§ 1037.235 Testing requirements for certification.

This section describes the emission testing you must perform to show compliance with respect to the greenhouse gas emission standards in subpart B of this part, and to determine any input values from §§ 1037.515 and 1037.520 that involve measured quantities.

(a) Select emission-data vehicles that represent production vehicles and components for the vehicle family consistent with the specifications in §§ 1037.205(o), 1037.515, and 1037.520. Where the test results will represent multiple vehicles or components with different emission performance, use good engineering judgment to select worst-case emission data vehicles. In the case of powertrain testing under § 1037.550, select a test engine and test transmission by considering the whole range of vehicle models covered by the powertrain family and the mix of duty cycles specified in § 1037.510.

(b) Test your emission-data vehicles (including emission-data components) using the procedures and equipment specified in subpart F of this part. Measure emissions (or other parameters, as applicable) using the specified procedures.

(c) We may measure emissions (or other parameters, as applicable) from any of your emission-data vehicles.

(1) We may decide to do the testing at your plant or any other facility. If we do this, you must deliver the vehicle or component to a test facility we designate. The vehicle or component you provide must be in a configuration that is suitable for testing. If we do the testing at your plant, you must schedule it as soon as possible and make available the instruments, personnel, and equipment we need.

(2) If we measure emissions (or other parameters, as applicable) from your vehicle or component, the results of that testing become the official emission results for the vehicle or component. Note that changing the official emission result does not necessarily require a change in the declared modeling input value. Unless we later invalidate these data, we may decide not to consider your data in determining if your vehicle family meets applicable requirements. This applies equally to individual data points from powertrain testing under § 1037.550 or § 1037.551, except that the results of our testing do not become the official emission result if our results are lower than your reported test results.

(3) Before we test one of your vehicles or components, we may set its adjustable parameters to any point within the physically adjustable ranges, if applicable.

(4) Before we test one of your vehicles or components, we may calibrate it within normal production tolerances for anything we do not consider an adjustable parameter. For example, this would apply for a vehicle parameter that is subject to production variability because it is adjustable during production, but is not considered an adjustable parameter (as defined in § 1037.801) because it is permanently sealed. For parameters that relate to a level of performance that is itself subject to a specified range (such as maximum power output), we will generally perform any calibration under this paragraph (c)(4) in a way that keeps performance within the specified range.

(d) You may ask to use carryover data for a vehicle or component from a previous model year instead of doing new tests if the applicable emission-data vehicle from the previous model year remains the appropriate emission-data vehicle under paragraph (b) of this section.

(e) We may require you to test a second vehicle or component of the same configuration in addition to the vehicle or component tested under paragraph (a) of this section.

(f) If you use an alternate test procedure under 40 CFR 1065.10 and later testing shows that such testing does not produce results that are equivalent to the procedures specified in subpart F of this part, we may reject data you generated using the alternate procedure.

§ 1037.241 Demonstrating compliance with exhaust emission standards for greenhouse gas pollutants.

(a) For purposes of certification, your vehicle family is considered in compliance with the CO_2 emission standards in §§ 1037.105 through 1037.107 if all vehicle configurations in that family have calculated or modeled CO_2 emission rates from § 1037.515 or § 1037.520 that are at or below the applicable standards. Note that FELs are considered to be the applicable emission standards with which you must comply if you participate in the ABT program in subpart H of this part. Your vehicle family is deemed not to comply if any vehicle configuration in that family has a calculated or modeled CO_2 emission rate that is above the applicable standard.

(b) In the case of trailer certification that does not rely on calculated CO_2 emission rates, your vehicle family is considered in compliance with the emission standards if all vehicle configurations in that family meet specified design standards and have TRRL values at or below the specified standard. Your family is deemed not to comply for certification if any trailer does not meet specified design standards or if any vehicle configuration in that family has a measured TRRL value above the specified standard.

(c) We may require you to provide an engineering analysis showing that the performance of your emission controls will not deteriorate during the useful life with proper maintenance. If we determine that your emission controls are likely to deteriorate during the useful life, we may require you to develop and apply deterioration factors consistent with good engineering judgment. For example, you may need to apply a deterioration factor to address deterioration of battery performance for a hybrid electric vehicle. Where the highest useful life emissions occur between the end of useful life and at the low-hour test point, base deterioration factors for the vehicles on the difference between (or ratio of) the point at which the highest emissions occur and the low-hour test point.

§ 1037.243 Demonstrating compliance with evaporative emission standards.

(a) For purposes of certification, your vehicle family is considered in compliance with the evaporative emission standards in subpart B of this part if you prepare an engineering analysis showing that your vehicles in the family will comply with applicable standards throughout the useful life, and there are no test results from an emission-data vehicle representing the family that exceed an emission standard.

(b) Your evaporative emission family is deemed not to comply if your engineering analysis is not adequate to show that all the vehicles in the family will comply with applicable emission standards throughout the useful life, or if a test result from an emission-data vehicle representing the family exceeds an emission standard.

(c) To compare emission levels with emission standards, apply deterioration factors to the measured emission levels. Establish an additive deterioration factor based on an engineering analysis that takes into account the expected aging from in-use vehicles.

(d) Apply the deterioration factor to the official emission result, as described in paragraph (c) of this section, then round the adjusted figure to the same number of decimal places as the emission standard. Compare the rounded emission levels to the emission standard for each emission-data vehicle.

(e) Your analysis to demonstrate compliance with emission standards must take into account your design strategy for vehicles that require testing. Specifically, vehicles above 14,000 pounds GVWR are presumed to need the same technologies that are required for heavy-duty vehicles at or below 14,000 pounds GVWR. Similarly, your analysis to establish a deterioration factor must take into account your testing to establish deterioration factors for smaller vehicles.

§ 1037.250 Reporting and recordkeeping.

(a) Within 90 days after the end of the model year, send the Designated Compliance Officer a report including the total U.S.-directed production volume of vehicles you produced in each vehicle family during the model year (based on information available at the time of the report). Report by vehicle identification number and vehicle configuration and identify the subfamily identifier. Report uncertified vehicles sold to secondary vehicle manufacturers. Small manufacturers may omit the reporting requirements of this paragraph (a).

(b) Organize and maintain the following records:

(1) A copy of all applications and any summary information you send us.

(2) Any of the information we specify in § 1037.205 that you were not required to include in your application.

(3) A detailed history of each emission-data vehicle (including emission-related components), if applicable.

(4) Production figures for each vehicle family divided by assembly plant.

(5) Keep a list of vehicle identification numbers for all the vehicles you produce under each certificate of conformity. Also identify the technologies that make up the certified configuration for each vehicle your produce.

(c) Keep required data from emission tests and all other information specified in this section for eight years after we issue your certificate. If you use the same emission data or other information for a later model year, the eight-year period restarts with each year that you continue to rely on the information.

(d) Store these records in any format and on any media, as long as you can promptly send us organized, written records in English if we ask for them. You must keep these records readily available. We may review them at any time.

(e) If you fail to properly keep records or to promptly send us information as required under this part, we may require that you submit the information specified in this section after each calendar quarter, and we may require that you routinely send us information that the regulation requires you to submit only if we request it. If we find that you are fraudulent or grossly negligent or otherwise act in bad faith regarding information reporting and recordkeeping, we may require that you send us a detailed description of the certified configuration for each vehicle before you produce it.

§ 1037.255 What decisions may EPA make regarding my certificate of conformity?

(a) If we determine your application is complete and shows that the vehicle family meets all the requirements of this part and the Act, we will issue a certificate of conformity for your vehicle family for that model year. We may make the approval subject to additional conditions.

(b) We may deny your application for certification if we determine that your vehicle family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny your application, we will explain why in writing.

(c) In addition, we may deny your application or suspend or revoke your certificate if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.

(2) Submit false or incomplete information (paragraph (e) of this section applies if this is fraudulent). This includes doing anything after submission of your application to render any of the submitted information false or incomplete.

(3) Render any test data inaccurate.

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

(5) Produce vehicles for importation into the United States at a location where local law prohibits us from carrying out authorized activities.

(6) Fail to supply requested information or amend your application to include all vehicles being produced.

(7) Take any action that otherwise circumvents the intent of the Act or this part, with respect to your vehicle family.

(d) We may void the certificate of conformity for a vehicle family if you fail to keep records, send reports, or give us information as required under this part or the Act. Note that these are also violations of 40 CFR 1068.101(a)(2).

(e) We may void your certificate if we find that you intentionally submitted false or incomplete information. This includes rendering submitted information false or incomplete after submission.

(f) If we deny your application or suspend, revoke, or void your certificate, you may ask for a hearing (see § 1037.820).

Subpart D—Testing Production Vehicles and Engines

§ 1037.301 Measurements related to GEM inputs in a selective enforcement audit.

(a) We may require you to perform selective enforcement audits under 40 CFR part 1068, subpart E, with respect to any GEM inputs in your application for certification. This section describes how this applies uniquely in certain circumstances.

(b) A selective enforcement audit consist of performing measurements with production vehicles relative to one or more declared values for GEM inputs, and using those measured values in place of your declared values to run GEM. The vehicle is considered passing if the new modeled emission result is at or below the modeled emission result corresponding to the declared GEM inputs. If you have reported an FEL for the vehicle configuration prior to the start of the audit, we will instead consider the vehicle passing if the new cycle-weighted emission result is at or below the FEL.

(c) For vehicles certified based on powertrain testing as specified in § 1037.550, we may apply the selective enforcement audit requirements to the powertrain. If engine manufacturers perform the powertrain testing and include those results in their certification under 40 CFR part 1036, they are responsible for selective enforcement audits related to those results. Otherwise, the certificate holder for the vehicle is responsible for the selective enforcement audit.

(1) A selective enforcement audit for powertrains would generally consist of performing a test with the complete powertrain (engine and transmission together). We may alternatively allow you to test the engine on a dynamometer with no installed transmission as described in § 1037.551.

(2) Recreate a set of test results for each of three separate powertrains. Generate weighted GEM results for each of ten separate configurations for each of the three selected powertrains. Each unique test run for a given configuration with a particular powertrain constitutes a separate test for purposes of evaluating whether the vehicle family meets the pass-fail criteria under 40 CFR 1068.420. The test result for a single test run in the audit is considered passing if it is at or below the value selected as an input for GEM. Perform testing with up to ten separate configurations for additional powertrains as needed to reach a pass-fail decision under 40 CFR 1068.240. For example, testing three powertrains over each of ten separate test runs would represent 30 tests; the family would have a pass result if 13 or fewer of the 30 tests are failing, and the family would have a fail result if 19 or more of the 30 tests are failing, and testing with an additional powertrain would be required if 14–18 of the 30 tests are failing. In the case of testing engines to simulate powertrain testing, apply the provisions of this paragraph (c)(2) based on separately simulated powertrains and vehicle configurations.

(d) To perform a selective enforcement audit with respect to drag area, use the same method you used for certification; we may instead require you to use the reference method specified in § 1037.525. For this paragraph (d), all measurements for tractors must include $F_{alt\text{-}aero}$ and adjustments to account for wind-averaged drag as applicable under § 1037.525. The following provisions apply instead of 40 CFR 1068.420 for a selective enforcement audit with respect to drag area:

(1) Determine whether or not a vehicle fails to meet standards as follows:

(i) For tractors, a failed vehicle is one whose measured drag area exceeds the maximum drag area corresponding to the bin you identified in your application for certification.

(ii) For trailers, a failed vehicle is a failed vehicle is one whose delta C_{DA} based on measured values is less than the minimum drag area corresponding to the bin you identified in your application for certification.

(2) Measure drag area for a minimum of two vehicles. If one of those vehicles fails, measure drag area for two additional vehicles from the vehicle family. If both of those vehicles fail, measure drag area for four additional vehicles from the vehicle family. You may perform testing on additional vehicles.

(3) Determine whether a vehicle family passes or fails the audit as follows:

(i) For tractors, you reach a pass decision for the audit if the arithmetic average value of the drag area for all tested vehicles is at or below the maximum value corresponding to the bin you identified in your application for certification. You reach a fail decision for the audit if this average value is above the maximum value corresponding to the bin you identified in your application for certification.

(ii) For trailers, you reach a pass decision for the audit if the arithmetic average value of delta C_DA is at or above the minimum value corresponding to the bin you identified in your application for certification. You reach a fail decision for the audit if this average value is below the minimum value corresponding to the bin you identified in your application for certification.

(4) In the case of trailer certification that relies on data from a device manufacturer under § 1037.211, we may require the device manufacturer to perform a selective enforcement audit as described in this paragraph (d). Our test order will establish the equivalent of a vehicle family for performing tests for the audit. If the audit leads to a fail result for the family, we may revoke our approval under § 1037.211 as that relates to any future application for certification.

(5) If we test some of your vehicles in addition to your testing, we may decide not to include your test results as official data for those vehicles if there is substantial disagreement between your testing and our testing. We will reinstate your data as valid if you show us that we made an error and your data are correct. If we perform testing, we may choose to stop testing after any number of tests.

(6) If we rely on our test data instead of yours, we will notify you in writing of our decision and the reasons we believe your facility is not appropriate for doing the tests we require under this paragraph (c). You may request in writing that we consider your test results from the same facility for future testing if you show us that you have made changes to resolve the problem.

(7) We may allow you to perform additional replicate tests with a given vehicle to reduce measurement variability, consistent with good engineering judgment.

(e) Selective enforcement audit provisions for fuel maps apply to engine manufacturers as specified in 40 CFR 1036.301.

(f) We may suspend or revoke certificates, based on the outcome of a selective enforcement audit, for any appropriate configurations within one or more vehicle families.

(g) We may apply selective enforcement audit provisions with respect to off-cycle technologies, with any necessary modifications, consistent with good engineering judgment.

Subpart E—In-Use Testing

§ 1037.401 General provisions.

(a) We may perform in-use testing of any vehicle subject to the standards of this part. For example, we may test vehicles to verify drag areas or other GEM inputs as specified in paragraph (b) of this section.

(b) We may measure the drag area of a vehicle you produced after it has been placed into service. We may use any of the procedures specified in § 1037.525 for measuring drag area. Your vehicle conforms to the regulations of this part with respect to aerodynamic performance if we measure its drag area to be at or below the maximum drag area allowed for the bin to which that configuration was certified.

Subpart F—Test and Modeling Procedures

§ 1037.501 General testing and modeling provisions.

This subpart specifies how to perform emission testing and emission modeling required elsewhere in this part.

(a) You must demonstrate that you meet emission standards using emission modeling as described in §§ 1037.515 and 1037.520. This modeling depends on several measured values as described in this subpart F. You may rely on fuel maps from the engine manufacturer as described in 40 CFR 1036.535, or you may instead use powertrain testing as described in § 1037.550.

(b) Where exhaust emission testing is required, use the equipment and procedures in 40 CFR part 1065 and/or part 1066, as applicable. Measure the emissions of all the exhaust constituents subject to emission standards as specified in 40 CFR part 1065 and/or part 1066, as applicable. Use the applicable duty cycles specified in § 1037.510.

(c) See 40 CFR 86.101 and 86.1813 for measurement procedures that apply for evaporative and refueling emissions.

(d) Use the applicable fuels specified 40 CFR part 1065 to perform valid tests.

(1) For service accumulation, use the test fuel or any commercially available fuel that is representative of the fuel that in-use vehicles will use.

(2) For diesel-fueled vehicles, use the appropriate diesel fuel specified for emission testing. Unless we specify otherwise, the appropriate diesel test fuel is ultra low-sulfur diesel fuel.

(3) For gasoline-fueled vehicles, use the gasoline specified for ''General Testing''.

(e) You may use special or alternate procedures as specified in 40 CFR 1065.10.

(f) This subpart is addressed to you as a manufacturer, but it applies equally to anyone who does testing for you, and to us when we perform testing to determine if your vehicles meet emission standards.

(g) Apply this paragraph (g) whenever we specify the use of standard trailers. Unless otherwise specified, a tolerance of ±2 inches applies for all nominal trailer dimensions.

(1) The standard trailer for high-roof tractors must meet the following criteria:

(i) It is an unloaded two-axle dry van box trailer 53.0 feet long, 102 inches wide, and 162 inches high (measured from the ground with the trailer level).

(ii) It has a king pin located with its center 36±0.5 inches from the front of the trailer and a minimized trailer gap (no greater than 45 inches).

(iii) It has a simple orthogonal shape with smooth surfaces and nominally flush rivets. Except as specified in paragraph (g)(1)(v) of this section, the standard trailer does not include any aerodynamic features such as side fairings, rear fairings, or gap reducers. It may have a scuff band no more than 0.13 inches thick.

(iv) It includes dual 22.5 inch wheels, standard tandem axle, standard mudflaps, and standard landing gear. The centerline of the tandem axle assembly must be 146±4 inches from the rear of the trailer. The landing gear must be installed in a conventional configuration.

(v) For the Phase 2 standards, include side skirts meeting the specifications of this paragraph (g)(1)(v). The side skirts must be mounted flush with the sides of the trailer and may extend as far forward as the centerline of the landing gear and as far rearward as the leading edge of the front wheel, with a height of 36±2 inches. We may approve your request to use a skirt with different dimensions if these specified values are impractical or inappropriate for your test trailer, and you propose alternative dimensions that provide an equivalent or comparable degree of aerodynamic drag for your test configuration.

(2) The standard trailer for mid-roof tractors is an empty two-axle tanker trailer 42±1 feet long by 140 inches high.

(i) It has a 40±1 feet long cylindrical tank with a 7000±7 gallon capacity, smooth surface, and rounded ends.

(ii) The standard tanker trailer does not include any aerodynamic features such as side fairings, but does include a centered 20 inch manhole, side-centered ladder, and lengthwise walkway. It includes dual 24.5 inch wheels.

(3) The standard trailer for low-roof tractors is an unloaded two-axle flat bed trailer 53±1 feet long and 102 inches wide.

(i) The deck height is 60.0±0.5 inches in the front and 55.0±0.5 inches in the rear. The standard trailer does not include any aerodynamic features such as side fairings.

(ii) It includes an air suspension and dual 22.5 inch wheels on tandem axles spread up to 122 inches apart between axle centerlines, measured along the length of the trailer.

(h) Use a standard tractor for measuring aerodynamic drag of trailers. Standard tractors must be certified at Bin III or better for Phase 1 or Phase 2 under § 1037.520(b)(1) or (3). The standard tractor for long trailers is a Class 8 high-roof sleeper cab. The standard tractor for short trailers is a Class 8 high-roof day cab.

§ 1037.510 Duty-cycle exhaust testing.

This section applies for Phase 2 powertrain testing, certain off-cycle testing under § 1037.610, and the Phase 1 advanced-technology provisions of § 1037.615.

(a) Measure emissions by testing the vehicle on a chassis dynamometer or the powertrain on a powertrain dynamometer with the applicable duty cycles. Each duty cycle consists of a series of speed commands over time—variable speeds for the transient test and constant speeds for the cruise tests. None of these cycles include vehicle starting or warmup.

(1) Perform testing for Phase 1 vehicles as follows to generate credits or adjustment factors for off-cycle or advanced technologies:

(i) *Transient cycle.* The transient cycle is specified in Appendix I of this part. Warm up the vehicle. Start the duty cycle within 30 seconds after concluding the warm-up procedure. Start sampling emissions at the start of the duty cycle.

(ii) *Cruise cycle.* For the 55 mph and 65 mph cruise cycles, warm up the vehicle at the test speed, then sample emissions for 300 seconds while maintaining vehicle speed within ±1.0 mph of the speed setpoint; this speed tolerance applies instead of the approach specified in 40 CFR 1066.425(b)(1) and (2).

(2) If you rely on powertrain testing under § 1037.550 for demonstrating compliance with Phase 2 vehicle standards, perform testing as described in this paragraph (a)(2) to generate GEM inputs for each of the eight or nine test runs representing different vehicle configurations, and for each of the four test runs representing different idle speed settings. You may perform any number of these test runs directly in succession once the vehicle is warmed up. For these tests and other powertrain tests, perform testing as follows:

(i) *Transient cycle.* The transient cycle is specified in Appendix I of this part. Warm up the vehicle by operating over one transient cycle. Within 60 seconds after concluding the warm up cycle, start emission sampling while the vehicle operates over the duty cycle.

(ii) *Cruise cycle.* The grade portion of the route corresponding to the 55 mph and 65 mph cruise cycles is specified in Appendix IV of this part. Warm up the vehicle by operating it at the appropriate speed setpoint over the duty cycle. Within 60 seconds after concluding the warm-up cycle, start emission sampling while the vehicle operates over the duty cycle, maintaining vehicle speed within ±1.0 mph of the speed setpoint; this speed tolerance applies instead of the approach specified in 40 CFR 1066.425(b)(1) and (2).

(iii) *Idle cycle.* Perform testing with the idle cycle for Phase 2 vocational vehicles. Warm up the vehicle by operating it at 65 mph for 600 seconds. Within 60 seconds after concluding the warm-up cycle, set the engine to operate at idle speed for 600 seconds, with the brake applied and the transmission in drive (or clutch depressed for manual transmission).

(3) For other testing of Phase 2 and later vehicles, perform testing on a chassis dynamometer as follows:

(i) *Transient cycle.* The transient cycle is specified in Appendix I of this part. Warm up the vehicle by operating over one transient cycle. Within 60 seconds after concluding the warm up cycle, start emission sampling while the vehicle operates over the duty cycle.

(ii) *Cruise cycle.* The grade portion of the route corresponding to the 55 mph and 65 mph cruise cycles is specified in Appendix IV of this part. Warm up the vehicle by operating it at the appropriate speed setpoint over the duty cycle. Within 60 seconds after concluding the warm-up cycle, start emission sampling while the vehicle operates over the duty cycle, maintaining vehicle speed within ±1.0 mph of the speed setpoint; this speed tolerance applies instead of the approach specified in 40 CFR 1066.425(b)(1) and (2).

(b) Calculate the official emission result from the following equation:

$$e_{\mathrm{CO2comp}} = \frac{1}{PL \cdot \bar{v}_{\mathrm{moving}}} \cdot \left((1 - w_{\mathrm{idle}}) \cdot \left(\frac{w_{transient} \cdot m_{transient}}{D_{transient}} + \frac{w_{55} \cdot m_{55}}{D_{55}} + \frac{w_{65} \cdot m_{65}}{D_{65}} \right) \cdot \bar{v}_{\mathrm{moving}} + w_{\mathrm{idle}} \cdot \bar{\dot{m}}_{\mathrm{idle}} \right) \quad \text{Eq. 1037.510-1}$$

Where:

e_{CO2comp} = total composite mass of CO_2 emissions in g/ton-mile, rounded to the nearest whole number.

PL = the standard payload, in tons, as specified in § 1037.705.

v_{moving} = mean composite weighted driven vehicle speed, excluding idle operation, as shown in Table 1 of this section for Phase 2 vocational vehicles. For other vehicles, let v_{moving} = 1.

$w_{[\mathrm{cycle}]}$ = weighting factor for the appropriate test cycle, as shown in Table 1 of this section.

$m_{[\mathrm{cycle}]}$ = CO_2 mass emissions over each test cycle (other than idle), in g/test.

$D_{[\mathrm{cycle}]}$ = the total driving distance for the indicated drive cycle. Use 2.84 miles for the transient cycle, and use 12.5 miles for both of the cruise cycles.

$\bar{\dot{m}}_{\mathrm{idle}}$= CO_2 emission rate at idle, in g/hr.

Example: Class 8 vocational vehicle meeting the Phase 2 standards based on the Regional duty cycle.

PL = 7.5 tons
$\bar{v}_{\mathrm{moving}}$ = 28.1 mph
$w_{\mathrm{transient}}$ = 50% = 0.50
w_{55} = 28% = 0.28
w_{65} = 22% = 0.22
w_{idle} = 10% = 0.10
$m_{\mathrm{transient}}$ = 6184.7 g
m_{55} = 5260.0 g
m_{65} = 7452.5 g
$D_{\mathrm{transient}}$ = 2.84
D_{55} = 12.5
D_{65} = 12.5
$\bar{\dot{m}}_{\mathrm{idle}}$= 11707 g/hr

$$e_{\mathrm{CO2}} = \frac{1}{7.5 \cdot 28.1} \cdot \left((1 - 0.10) \cdot \left(\frac{0.50 \cdot 6184.7}{2.84} + \frac{0.28 \cdot 5260.0}{12.5} + \frac{0.22 \cdot 7452.5}{12.5} \right) \cdot 28.1 + 0.10 \cdot 11707 \right) = 166.1 \text{ g/ton-mile}$$

(c) Apply weighting factors specific to each type of vehicle and for each duty cycle as follows:

(1) Apply weighting factors for tractors as shown in Table 1 of this section. Note that the weighting factors specified here are equivalent to weighting factors in GEM.

(2) Apply weighting factors for vocational vehicles as shown in Table 1 of this section. For Phase 2 vocational vehicles, select the most appropriate duty cycle for modeling emission results with each vehicle configuration. The default is the Multi-Purpose Duty Cycle. You may need to instead select the Regional Duty Cycle or the Urban Duty Cycle as follows:

(i) Except as specified in paragraph (c)(2)(iii) of this section, use the Regional Duty Cycle for each configuration meeting any of the following characteristics:

(A) The vehicle configuration as modeled in GEM reaches a speed of 65 miles per hour at less than 75% of maximum test speed for compression-ignition engines, and at less than 45% maximum test speed for spark-ignition engines, when operating in the highest available transmission gear. Maximum test speed is the highest speed from the engine's fuel map.

(B) The vehicle is intended to be used as an intercity bus.

(C) The vehicle is intended to be used for temporary housing, such as for camping.

(D) The engine was certified based on testing only with the ramped-modal cycle.

(ii) Except as specified in paragraph (c)(2)(iii) of this section, use the Urban Duty Cycle for each configuration meeting any of the following characteristics:

(A) The vehicle configuration as modeled in GEM does not reach a speed of 55 miles per hour before the engine is at or above 90% of maximum test speed for compression-ignition engines, and at or above 50% maximum test speed for spark-ignition engines, when operating in the highest available transmission gear.

(B) The vehicle has a hybrid powertrain.

(iii) You may ask us to make a different determination with respect to the duty cycle than we specify in this paragraph (c)(2) if you can demonstrate that a different duty cycle is more appropriate for a certain vehicle configuration.

(3) Use the values for weighting factors and average speed in the following table to properly simulate the appropriate duty cycle:

TABLE 1 OF § 1037.510—WEIGHTING FACTORS FOR DUTY CYCLES

	Distance-weighted			Time-weighted		Average speed while moving, (mph)
	Transient (percent)	55 mph cruise (percent)	65 mph cruise (percent)	Idle (percent)	Non-idle (percent)	
Day Cabs	19	17	64			
Sleeper Cabs	5	9	86			
Heavy-haul tractors	19	17	64			
Vocational—Multi-Purpose	82	15	3	15	85	20.9
Vocational—Regional	50	28	22	10	90	28.1
Vocational—Urban	94	6	0	20	80	19.2

TABLE 1 OF § 1037.510—WEIGHTING FACTORS FOR DUTY CYCLES—Continued

	Distance-weighted			Time-weighted		Average speed while moving, (mph)
	Transient (percent)	55 mph cruise (percent)	65 mph cruise (percent)	Idle (percent)	Non-idle (percent)	
Vocational with conventional powertrain (Phase 1 only)	42	21	37			
Vocational Hybrid Vehicles (Phase 1 only)	75	9	16			

(d) For transient testing, compare actual second-by-second vehicle speed with the speed specified in the test cycle and ensure any differences are consistent with the criteria as specified in 40 CFR 1066.425. If the speeds do not conform to these criteria, the test is not valid and must be repeated.

(e) Run test cycles as specified in 40 CFR part 1066. For cruise cycle testing of vehicles equipped with cruise control, use the vehicle's cruise control to control the vehicle speed. For vehicles equipped with adjustable vehicle speed limiters, test the vehicle with the vehicle speed limiter at its highest setting.

(f) For Phase 1, test the vehicle using its adjusted loaded vehicle weight, unless we determine this would be unrepresentative of in-use operation as specified in 40 CFR 1065.10(c)(1).

(g) For hybrid vehicles, correct for the net energy change of the energy storage device as described in 40 CFR 1066.501.

§ 1037.515 Determining CO_2 emissions to show compliance for trailers.

This section describes a compliance approach for trailers that is consistent with the modeling for vocational vehicles and tractors described in § 1037.520, but is simplified consistent with the smaller number of trailer parameters that affect CO_2 emissions. Note that the calculated CO_2 emission rate, e_{CO2}, is equivalent to the value that would result from running GEM with the same input values.

(a) *Compliance equation.* Calculate CO_2 emissions for demonstrating compliance with emission standards for each trailer configuration using the following equation:

$$e_{CO2} = (C_1 + C_2 \cdot TRRL + C_3 \cdot \Delta C_D A + C_4 \cdot WR) \cdot C_5 \quad \text{Eq. 1037.515-1}$$

Where:

C_i = constant values for calculating CO_2 emissions from this regression equation derived from GEM, as shown in Table 1 of this section. Let C_5 = 0.985 for trailers that have automatic tire inflation systems with all wheels; otherwise, let C_5 = 1.

$TRRL$ = tire rolling resistance level, in kg per metric ton, as specified in paragraph (b) of this section.

$\Delta C_D A$ = the delta $C_D A$ value for the trailer, in m^2, as specified in paragraph (c) of this section.

WR = weight reduction, in pounds, as specified in paragraph (d) of this section.

TABLE 1 OF § 1037.515—REGRESSION COEFFICIENTS FOR CALCULATING CO_2 EMISSIONS

Trailer category	C_1	C_2	C_3	C_4
Long dry box ban	77.4	1.7	−6.1	−0.001
Long refrigerated box van	78.3	1.8	−6.0	−0.001
Short dry box van	134.0	2.2	−10.5	−0.003
Short refrigerated box van	136.3	2.4	−10.3	−0.003

(b) *Tire rolling resistance.* Use the procedure specified in § 1037.520(c) to determine the tire rolling resistance level for your tires. Note that you may base tire rolling resistance levels on measurements performed by tire manufacturers, as long as those measurements meet this part's specifications.

(c) *Drag area.* You may use delta $C_D A$ values approved under § 1037.211 for device manufacturers if your trailers are properly equipped with those devices. Determine delta $C_D A$ values for other trailers based on testing. Measure $C_D A$ and determine delta $C_D A$ values as described in § 1037.525(a). You may use delta $C_D A$ values from one trailer configuration to represent any number of additional trailers based on worst-case testing. This means that you may apply delta $C_D A$ values from your measurements to any trailer models of the same category with drag area at or below that of the tested configuration. For trailers in the ''short trailer'' subcategory that are not 28 feet long, apply the delta $C_D A$ value established for a comparable 28-foot trailer model; you may use the same devices designed for 28-foot trailers or you may adapt those devices as appropriate for the different trailer length, consistent with good engineering judgment. For example, 48-foot trailers may use longer side skirts than the skirts that were tested with a 28-foot trailer. Trailer and device manufacturers may seek preliminary approval for these adaptations. Determine bin levels based on delta $C_D A$ test results as described in the following table:

TABLE 2 OF § 1037.515—BIN DETERMINATIONS FOR TRAILERS BASED ON AERODYNAMIC TEST RESULTS

[delta C_DA in m²]

If a trailer's measured delta C_DA is . . .	designated the trailer as . . .	and use the following values for delta C_DA
≤ 0.09	Bin I	0.0
0.10–0.19	Bin II	0.1
0.20–0.39	Bin III	0.3
0.40–0.59	Bin IV	0.5
0.60–0.79	Bin V	0.7
0.80–1.19	Bin VI	1.0
1.20–1.59	Bin VII	1.4
≥1.60	Bin VIII	1.8

(d) *Weight reduction.* Determine weight reduction for a trailer configuration by summing all applicable values, as follows:

(1) Determine weight reduction for using lightweight materials for wheels as described in § 1037.520(e).

(2) Apply weight reductions for other components made with light-weight materials as shown in the following table:

TABLE 3 OF § 1037.515—WEIGHT REDUCTIONS FOR TRAILERS

[pounds]

Component	Material	Weight reduction (pounds)
Structure for Suspension Assembly [1]	Aluminum	280
Hub and Drum (per axle)	Aluminum	80
Floor	Aluminum	375
Floor	Composite (wood and plastic)	245
Floor Crossmembers	Aluminum	203
Landing Gear	Aluminum	50
Rear Door	Aluminum	187
Rear Door Surround	Aluminum	150
Roof Bows	Aluminum	100
Side Posts	Aluminum	300
Slider Box	Aluminum	150
Upper Coupler Assembly	Aluminum	430

[1] For tandem-axle suspension sub-frames made of aluminum, apply a weight reduction of 280 pounds. Use good engineering judgment to estimate a weight reduction for using aluminum sub-frames with other axle configurations.

§ 1037.520 Modeling CO_2 emissions to show compliance for vocational vehicles and tractors.

This section describes how to use the Greenhouse gas Emissions Model (GEM) simulation tool (incorporated by reference in § 1037.810) to show compliance with the CO_2 standards of §§ 1037.105 and 1037.106 for vocational vehicles and tractors. Use GEM version 2.0.1 to demonstrate compliance with Phase 1 standards; use GEM Phase 2 version 1.0 (''GEM_P2v1.0'') to demonstrate compliance with Phase 2 standards. Use good engineering judgment when demonstrating compliance using GEM. See § 1037.515 for calculation procedures for demonstrating compliance with trailer standards.

(a) *General modeling provisions.* To run GEM, enter all applicable inputs as specified by the model.

(1) GEM inputs apply for Phase 1 and Phase 2 standards as follows:

(i) Regulatory subcategory (see § 1037.230).

(ii) Coefficient of aerodynamic drag or drag area, as described in paragraph (b) of this section (tractors only).

(iii) Steer tire rolling resistance, as described in paragraph (c) of this section.

(iv) Drive tire rolling resistance, as described in paragraph (c) of this section.

(v) Vehicle speed limit, as described in paragraph (d) of this section (tractors only).

(vi) Vehicle weight reduction, as described in paragraph (e) of this section (tractors only for Phase 1).

(vii) Credit for idle-reduction strategies, as described in paragraph (f) of this section (only for Class 8 sleeper cabs and Phase 2 vocational vehicles).

(2) Additional GEM inputs apply for Phase 2 standards as follows:

(i) Transmission make, model, and type. Also identify the gear ratio for every available forward gear to two decimal places.

(ii) Engine make, model, fuel type, engine family name, calibration identification. Also identify whether the engine is subject to spark-ignition or compression-ignition standards under 40 CFR part 1036.

(iii) Drive axle ratio, k_a. If a vehicle is designed with two or more user-selectable axle ratios, use the drive axle ratio that is expected to be engaged for the greatest driving distance. If the vehicle does not have a drive axle, such as a hybrid vehicle with direct electric drive, let k_a = 1.

(iv) Various engine and vehicle operational characteristics, as described in paragraph (f) of this section.

(v) Engine fuel map, as described in paragraph (g) of this section. Include fuel consumption at idle for vocational vehicles.

(vi) Engine full-load torque curve and motoring torque curve, as described in paragraph (h) of this section.

(vii) Loaded tire radius for drive tires, expressed to the nearest 0.01 m, as described in paragraph (c) of this section.

(viii) Vehicles with hybrid power take-off, as described in paragraph (j) of this section (vocational vehicles only).

(ix) Declared engine idle speed at CITT. This is the engine's idle speed when the vehicle is in drive.

(3) You may certify your vehicles based on powertrain testing as described in § 1037.550, rather than fuel maps, to characterize fuel consumption rates at different speed and torque values as follows:

(i) Compliance based on powertrain testing is required for hybrid electric vehicles and all vehicles with a transmission that is not automatic, automated manual, manual, or dual-clutch. Compliance based on powertrain testing is optional for all other vehicles.

(ii) GEM inputs associated with powertrain testing include powertrain family, transmission calibration, test data from § 1037.550, and the powertrain test configuration (dynamometer connected to transmission output or wheel hub). You do not need to identify or provide inputs for transmission gear ratios, fuel map data, or engine torque curves, which would otherwise be required under paragraph (a)(2) of this section.

(iii) Fuel consumption at idle is still required for vocational vehicles.

(4) If you certify emergency vehicles to the alternative standards specified in § 1037.105(b)(4), run GEM by identifying the vehicle as an emergency vehicle and enter values for tire rolling resistance as specified in paragraph (c) of this section. GEM requires no additional data entry for qualifying emergency vehicles.

(5) You may use a default fuel map for specialty vehicles using engines certified to alternate standards under § 1037.605.

(b) *Coefficient of aerodynamic drag and drag area.* Determine the appropriate drag area, C_DA, for tractors as described in this paragraph (b). Use the recommended method or an alternate method to establish a value for C_DA, expressed in m² to one decimal place, as specified in § 1037.525. Where we allow you to group multiple configurations together, measure C_DA of the worst-case configuration.

(1) Except as specified in paragraph (b)(2) of this section, determine the Phase 1 bin level for your vehicle based on measured C_DA values as shown in the following tables:

TABLE 1 OF § 1037.520—C_D INPUTS FOR PHASE 1 HIGH-ROOF TRACTORS

Tractor type	Bin level	If your measured C_{DA} (m²) is . . .	Then your C_D input is . . .
High-Roof Day Cabs	Bin I	≥ 8.0	0.79
	Bin II	7.1–7.9	0.72
	Bin III	6.2–7.0	0.63
	Bin IV	5.6–6.1	0.56
	Bin V	≤ 5.5	0.51
High-Roof Sleeper Cabs	Bin I	≥ 7.6	0.75
	Bin II	6.8–7.5	0.68
	Bin III	6.3–6.7	0.60
	Bin IV	5.6–6.2	0.52
	Bin V	≤5.5	0.47

TABLE 2 OF § 1037.520—C_D INPUTS FOR PHASE 1 LOW-ROOF AND MID-ROOF TRACTORS

Tractor type	Bin level	If your measured C_DA (m²) is . . .	Then your C_D input is . . .
Low-Roof Day and Sleeper Cabs	Bin I	≥ 5.1	0.77
	Bin II	≤ 5.0	0.71
Mid-Roof Day and Sleeper Cabs	Bin I	≥ 5.6	0.87
	Bin II	≤ 5.5	0.82

(2) For Phase 1 low- and mid-roof tractors, you may instead determine your drag area bin based on the drag area bin of an equivalent high-roof tractor. If the high-roof tractor is in Bin I or Bin II, then you may assume your equivalent low- and mid-roof tractors are in Bin I. If the high-roof tractor is in Bin III, Bin IV, or Bin V, then you may assume your equivalent low- and mid-roof tractors are in Bin II.

(3) For Phase 2 tractors other than heavy-haul tractors, determine bin levels and C_{DA} inputs as follows:

(i) Determine bin levels for high-roof tractors based on aerodynamic test results as described in the following table:

TABLE 3 OF § 1037.520—BIN DETERMINATIONS FOR PHASE 2 HIGH-ROOF TRACTORS BASED ON AERODYNAMIC TEST RESULTS

[C_{DA} in m²]

Tractor type	Bin I	Bin II	Bin III	Bin IV	Bin V	Bin VI	Bin VII
Day Cabs	≥7.5	6.8–7.4	6.2–6.7	5.6–6.1	5.1–5.5	4.7–5.0	≤4.6
Sleeper Cabs	≥7.3	6.6–7.2	6.0–6.5	5.4–5.9	4.9–5.3	4.5–4.8	≤4.4

(ii) For low- and mid-roof tractors, you may determine your bin level based on aerodynamic test results as described in Table 4 of this section, or based on the bin level of an equivalent high-roof tractor as shown in Table 5 of this section.

TABLE 4 OF § 1037.520—BIN DETERMINATIONS FOR PHASE 2 LOW-ROOF AND MID-ROOF TRACTORS BASED ON AERODYNAMIC TEST RESULTS

[C_{DA} in m^2]

Tractor type	Bin I	Bin II	Bin III	Bin IV
Low-Roof Cabs	≥5.1	4.6–5.0	4.2–4.5	≤4.1
Mid-Roof Cabs	≥6.5	6.0–6.4	5.6–5.9	≤5.5

TABLE 5 OF § 1037.520—BIN DETERMINATIONS FOR PHASE 2 LOW- AND MID-ROOF TRACTORS BASED ON EQIVALENT HIGH-ROOF TRACTORS

If your equivalent high-roof tractor is . . .	then the corresponding low- and mid-roof tractors is . . .
Bin I	Bin I.
Bin II	Bin I.
Bin III	Bin II.
Bin IV	Bin II.
Bin V	Bin III.
Bin VI	Bin III.
Bin VII	Bin IV.

(iii) Determine the C_{DA} input according to the tractor's bin level as described in the following table:

TABLE 6 OF § 1037.520—PHASE 2 C_{DA} TRACTOR INPUTS BASED ON BIN LEVEL

Tractor type	Bin I	Bin II	Bin III	Bin IV	Bin V	Bin VI	Bin VII
High-Roof Day Cabs	7.6	7.1	6.5	5.8	5.3	4.9	4.5
High-Roof Sleeper Cabs	7.4	6.9	6.3	5.6	5.1	4.7	4.3
Low-Roof Cabs	5.3	4.8	4.3	4.0			
Mid-Roof Cabs	6.7	6.2	5.7	5.4			

(c) *Tire radius and rolling resistance.* You must have a loaded radius and a tire rolling resistance level (TRRL) for each tire configuration. For purposes of this section, you may consider tires with the same SKU number to be the same configuration. Determine TRRL input values separately for drive and steer tires; determine tire radius only for drive tires.

(1) Determine a tire's loaded radius as specified in ISO 28580 (incorporated by reference in § 1037.810).

(2) Measure tire rolling resistance in kg per metric ton as specified in ISO 28580 (incorporated by reference in § 1037.810), except as specified in this paragraph (c). Use good engineering judgment to ensure that your test results are not biased low. You may ask us to identify a reference test laboratory to which you may correlate your test results. Prior to beginning the test procedure in Section 7 of ISO 28580 for a new bias-ply tire, perform a break-in procedure by running the tire at the specified test speed, load, and pressure for 60±2 minutes.

(3) For each tire design tested, measure rolling resistance of at least three different tires of that specific design and size. Perform the test at least once for each tire. Use the arithmetic mean of these results as your test result. You may use this value or any higher value as your GEM input for TRRL. You must test at least one tire size for each tire model, and may use engineering analysis to determine the rolling resistance of other tire sizes of that model. Note that for tire sizes that you do not test, we will treat your analytically derived rolling resistances the same as test results, and we may perform our own testing to verify your values. We may require you to test a small sub-sample of untested tire sizes that we select.

(4) If you obtain your test results from the tire manufacturer or another third party, you must obtain a signed statement from the party supplying those test results to verify that tests were conducted according to the requirements of this part. Such statements are deemed to be submissions to EPA.

(5) For tires marketed as light truck tires and that have load ranges C, D, or E, use as the GEM input TRRL multiplied by 0.87.

(d) *Vehicle speed limit.* If the vehicles will be equipped with a vehicle speed limiter, input the maximum vehicle speed to which the vehicle will be limited (in miles per hour rounded to the nearest 0.1 mile per hour) as specified in § 1037.640. Otherwise leave this field blank. Use good engineering judgment to ensure the limiter is tamper resistant. We may require you to obtain preliminary approval for your designs.

(e) *Vehicle weight reduction.* Develop a weight-reduction as a GEM input as described in this paragraph (e). For purposes of this paragraph (e), high-strength steel is steel with tensile strength at or above 350 MPa.

(1) Vehicle weight reduction inputs for wheels are specified relative to dual-

wide tires with conventional steel wheels. For purposes of this paragraph (e)(1), an aluminum alloy qualifies as light-weight if a dual-wide drive wheel made from this material weighs at least 21 pounds less than a comparable conventional steel wheel. The inputs are listed in Table 7 of this section. For example, a tractor or vocational vehicle with aluminum steer wheels and eight (4×2) dual-wide aluminum drive wheels would have an input of 210 pounds (2×21 + 8×21).

TABLE 7 OF § 1037.520—WHEEL-RELATED WEIGHT REDUCTIONS

Weight-Reduction Technology		Weight Reduction (lb per tire or wheel)
Wide-Based Single Drive Tire or Wide-Based Single Trailer Tire with . . .	Steel Wheel	84
	Aluminum Wheel	139
	Light-Weight Aluminum Alloy Wheel	147
Steer Tire, Dual-wide Drive Tire, or Dual-wide Trailer Tire with . . .	High-Strength Steel Wheel	8
	Aluminum Wheel	21
	Light-Weight Aluminum Alloy Wheel	30

(2) Weight reduction inputs for tractor components other than wheels are specified in the following table:

TABLE 8 OF § 1037.520—NONWHEEL-RELATED WEIGHT REDUCTIONS FROM ALTERNATIVE MATERIALS FOR TRACTORS

[pounds]

Weight reduction technologies	Aluminum	High-strength steel	Thermoplastic
Door	20	6	
Roof	60	18	
Cab rear wall	49	16	
Cab floor	56	18	
Hood Support Structure System	15	3	
Hood and Front Fender			65
Day Cab Roof Fairing			18
Sleeper Cab Roof Fairing	75	20	40
Aerodynamic Side Extender			10
Fairing Support Structure System	35	6	
Instrument Panel Support Structure	5	1	
Brake Drums—Drive (4)	140	11	
Brake Drums—Non Drive (2)	60	8	
Frame Rails	440	87	
Crossmember—Cab	15	5	
Crossmember—Suspension	25	6	
Crossmember—Non Suspension (3)	15	5	
Fifth Wheel	100	25	
Radiator Support	20	6	
Fuel Tank Support Structure	40	12	
Steps	35	6	
Bumper	33	10	
Shackles	10	3	
Front Axle	60	15	
Suspension Brackets, Hangers	100	30	
Transmission Case	50	12	
Clutch Housing	40	10	
Fairing Support Structure System	35	6	
Drive Axle Hubs (per 4)	80	20	
Non Drive Hubs (2)	40	5	
Driveshaft	20	5	
Transmission/Clutch Shift Levers	20	4	

(3) Weight-reduction inputs for vocational-vehicle components other than wheels are specified in the following table:

TABLE 9 OF § 1037.520—NONWHEEL-RELATED WEIGHT REDUCTIONS FROM ALTERNATIVE MATERIALS FOR PHASE 2 VOCATIONAL VEHICLES

[pounds]

<table>
<tr><th rowspan="2">Component</th><th rowspan="2">Material</th><th colspan="3">Vehicle type</th></tr>
<tr><th>Class 2b–5 vocational vehicle</th><th>Class 6–7 ocational vehicle</th><th>Class 8 ocational vehicle</th></tr>
<tr><td>Axle Hubs—Non-Drive</td><td>Aluminum</td><td colspan="2">40</td><td>40</td></tr>
<tr><td>Axle Hubs—Non-Drive</td><td>High Strength Steel</td><td colspan="2">5</td><td>5</td></tr>
<tr><td>Axle—Non-Drive</td><td>Aluminum</td><td colspan="2">60</td><td>60</td></tr>
<tr><td>Axle—Non-Drive</td><td>High Strength Steel</td><td colspan="2">15</td><td>15</td></tr>
<tr><td>Brake Drums—Non-Drive</td><td>Aluminum</td><td colspan="2">60</td><td>60</td></tr>
<tr><td>Brake Drums—Non-Drive</td><td>High Strength Steel</td><td colspan="2">8</td><td>8</td></tr>
<tr><td>Axle Hubs—Drive</td><td>Aluminum</td><td colspan="2">40</td><td>80</td></tr>
<tr><td>Axle Hubs—Drive</td><td>High Strength Steel</td><td colspan="2">10</td><td>20</td></tr>
<tr><td>Brake Drums—Drive</td><td>Aluminum</td><td colspan="2">70</td><td>140</td></tr>
<tr><td>Brake Drums—Drive</td><td>High Strength Steel</td><td colspan="2">5.5</td><td>11</td></tr>
<tr><td>Clutch Housing</td><td>Aluminum</td><td colspan="2">34</td><td>40</td></tr>
<tr><td>Clutch Housing</td><td>High Strength Steel</td><td colspan="2">9</td><td>10</td></tr>
<tr><td>Suspension Brackets, Hangers</td><td>Aluminum</td><td colspan="2">67</td><td>100</td></tr>
<tr><td>Suspension Brackets, Hangers</td><td>High Strength Steel</td><td colspan="2">20</td><td>30</td></tr>
<tr><td>Transmission Case</td><td>Aluminum</td><td colspan="2">45</td><td>50</td></tr>
<tr><td>Transmission Case</td><td>High Strength Steel</td><td colspan="2">11</td><td>12</td></tr>
<tr><td>Crossmember—Cab</td><td>Aluminum</td><td>10</td><td>14</td><td>15</td></tr>
<tr><td>Crossmember—Cab</td><td>High Strength Steel</td><td>2</td><td>4</td><td>5</td></tr>
<tr><td>Crossmember—Non-Suspension</td><td>Aluminum</td><td>15</td><td>18</td><td>21</td></tr>
<tr><td>Crossmember—Non-Suspension</td><td>High Strength Steel</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Crossmember—Suspension</td><td>Aluminum</td><td>15</td><td>20</td><td>25</td></tr>
<tr><td>Crossmember—Suspension</td><td>High Strength Steel</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>Driveshaft</td><td>Aluminum</td><td>12</td><td>40</td><td>50</td></tr>
<tr><td>Driveshaft</td><td>High Strength Steel</td><td>5</td><td>10</td><td>12</td></tr>
<tr><td>Frame Rails</td><td>Aluminum</td><td>120</td><td>300</td><td>440</td></tr>
<tr><td>Frame Rails</td><td>High Strength Steel</td><td>24</td><td>40</td><td>87</td></tr>
</table>

(4) Apply vehicle weight inputs for changing technology configurations as follows:

(i) For Class 8 tractors or Class 8 vocational vehicles with a permanent 6×2 axle configuration, apply a weight reduction input of 300 pounds.

(ii) For Class 8 tractors with 4×2 axle configuration, apply a weight reduction input of 400 pounds.

(iii) For tractors with installed engines with displacement below 14.0 liters, apply a weight reduction of 300 pounds.

(iv) GEM accounts for increased vehicle weight for vehicles that use natural gas. For vehicles that use a fuel other than diesel fuel, gasoline, or natural gas, use good engineering judgment to determine an appropriate weight adjustment relative to a comparable vehicle fueled by gasoline or diesel fuel. This may require a negative value.

(5) You may ask to apply the off-cycle technology provisions of § 1037.610 for weight reductions not covered by this paragraph (e).

(f) *Additional vehicle characteristics.* GEM accounts for CO_2 emission reductions for certain technologies and vehicle configurations as noted in this paragraph (f) for Phase 2 vehicles. Because these adjustments are made internal to GEM, you need to identify the features as GEM inputs rather than separately applying these adjustments to GEM results. These adjustments (as applicable for GEM 3.0) are summarized for informational purposes only.

(1) GEM applies a 2.5% emission reduction for single drive axles with the following Class 8 vehicles:

(i) Tractors in a 4×2 configuration.

(ii) Vocational vehicles and tractors with a permanent 6×2 configuration. The same emission reduction applies for part-time 6×2 configurations, but only for the cruise cycles specified in § 1037.510.

(2) GEM applies a 0.5% emission reduction for vehicles that use a low-friction drive axle lubricant, as follows:

(i) A lubricant qualifies if it meets the specifications for BASF Emgard FE 2986 as described in ''Emgard® FE 75W–90 Fuel Efficient Synthetic Gear Lubricant'' (incorporated by reference in § 1037.810).

(ii) You may use A to B testing using the procedures in § 1037.560 to show that a lubricant performs at an equivalent or superior level relative to a lubricant specified in paragraph (f)(2)(i) of this section. Testing must show equivalent or superior performance at every specified speed and torque value.

(3) GEM applies a 2% emission reduction for tractors if they have an automatic transmission, an automated manual transmission, or a dual-clutch transmission. Similarly, GEM applies a 2.3% emission reduction for Class 8 vocational vehicles certified with the Regional duty cycle if they have an automated manual transmission or a dual-clutch transmission.

(4) GEM applies a 2% emission reduction for tractors with predictive cruise control. This includes any cruise control system that incorporates satellite-based global-positioning data for controlling operator demand.

(5) GEM applies a 0.5% emission reduction for tractors with a high-efficiency air conditioning compressor. This includes mechanically powered compressors meeting the specifications described in 40 CFR 86.1868–12(h)(5), and all electrically powered compressors.

(6) GEM applies a 1% emission reduction for tractors with electrically powered pumps for steering and engine cooling.

(7) GEM applies a 1% emission reduction for tractors with automatic tire inflation systems.

(8) GEM accounts for emission reductions for reduced idle for the following technologies:

(i) *Stop-start technology for vocational vehicles.* Phase 2 vocational vehicles qualify for reduced emissions in GEM modeling if the engine shuts down no more than 30 seconds after the onset of any of the following conditions:

(A) The vehicle's brake is depressed at a zero-speed condition.

(B) A vehicle with automatic transmission goes into ''Park''.

(ii) *Neutral-idle technology for vocational vehicles.* A Phase 2 vocational vehicle with an automatic transmission qualifies for reduced emissions in GEM modeling if the vehicle goes into neutral (or reduces torque equivalent to being in neutral) at a zero-speed condition.

(iii) *Extended-idle reduction.* If your sleeper cab is equipped with idle reduction technology meeting the requirements of § 1037.660 that will automatically shut off the main engine after 300 seconds or less, GEM applies a 5 percent emission reduction for Phase 2 vehicles. For Phase 1, enter 5.0 g/ton-mile as the input (or a lesser value specified in § 1037.660); otherwise leave this field blank.

(g) *Engine fuel mapping and fuel consumption at idle.* Use the fuel map and fuel consumption at idle from the engine manufacturer to characterize the engine's specific fuel consumption, or create a new fuel map and determine fuel consumption at idle as described in 40 CFR 1036.535.

(h) *Engine full-load torque curve and motoring torque curve.* Use the full-load torque curve and the motoring torque map from the engine manufacturer or create new maps as described in 40 CFR 1065.510(b) and (c)(2).

(i) *Vehicles with hybrid power take-off.* Determine the delta PTO emission result of your engine and hybrid power take-off system as described in § 1037.540.

(j) *Alternate fuels.* For fuels other than those identified in GEM, perform the simulation by identifying the vehicle as being diesel-fueled, but use a fuel map based on the mass flow rates of the alternate fuel.

§ 1037.525 Aerodynamic measurements.

This section describes a methodology for determining aerodynamic drag area, C_DA for use in determining input values for §§ 1037.515 and 1037.520.

(a) *General provisions for trailers.* A trailer's aerodynamic performance for demonstrating compliance with standards is based on a delta C_DA value relative to a baseline trailer. Determine these delta C_DA values by performing A to B testing, as follows:

(1) The default method for measuring C_DA is a coastdown procedure as specified in § 1037.527. If we approve it in advance, you may instead use one of the alternative methods specified in §§ 1037.529 through 1037.533, consistent with good engineering judgment. If you request our approval to determine drag area using an alternative method, you must submit additional information as described in paragraph (c) of this section.

(2) Determine a baseline C_DA value for a standard tractor pulling a test trailer representing a production configuration; use a 53-foot test trailer to represent long trailers and a 28-foot test trailer to represent short trailers. Repeat this testing with the same tractor and a baseline trailer. For testing long trailers, the baseline trailer is a trailer meeting the specifications for a Phase 1 standard trailer in § 1037.501(g)(1); for testing refrigerated box vans, install an HVAC unit on the baseline trailer that properly represents a baseline configuration. For testing short trailers, use a 28-foot baseline trailer with a single axle that meets the same specifications as the Phase 1 standard trailer, except as needed to accommodate the reduced trailer length. Use good engineering judgment to perform paired tests that accurately demonstrate the reduction in aerodynamic drag associated with the improved design. Measure C_DA in m² to two decimal places. Calculate delta C_DA by subtracting the drag area for the test trailer from the drag area for the baseline trailer.

(b) *General provisions for tractors.* The GEM input for a tractor's aerodynamic performance is an absolute C_DA value that is measured or calculated for a tractor in a test configuration. Test high-roof tractors with a standard box trailer. Note that the standard box trailer for Phase 1 tractors is different from that of later model years. Test low-roof and mid-roof tractors without a trailer; however, you may test low-roof and mid-roof tractors with a trailer to evaluate off-cycle technologies. The default method for determining C_DA values is a coastdown procedure as specified in § 1037.527. If we approve it in advance, you may instead use one of the alternative methods specified in §§ 1037.529 through 1037.533, or some other method, based on a correlation to coastdown testing, consistent with good engineering judgment. Submit information describing how you determined C_DA values from coastdown testing whether or not you use an alternative method. If you request our approval to determine drag area using an alternative method, C_DA_{alt}, you must submit additional information as described in paragraph (c) of this section and adjust the C_DA values to be equivalent to the corresponding values from coastdown measurements as follows:

(1) Unless good engineering judgment requires otherwise, assume that coastdown drag areas are proportional to drag areas measured using alternative methods. This means you may apply a single constant adjustment factor, $F_{alt\text{-}aero}$, for a given alternate drag area method using the following equation:

$$C_DA = C_DA_{alt} \cdot F_{alt\text{-}aero} \qquad \text{Eq. 1037.525-1}$$

(2) Determine $F_{alt\text{-}aero}$ by performing coastdown testing and applying your alternate method on the same vehicle. Unless we approve another vehicle, the vehicle must be a Class 8, high-roof, sleeper cab with a full aerodynamics package, pulling a standard trailer. Where you have more than one tractor model meeting these criteria, use the tractor model with the highest projected sales. If you do not have such a tractor model, you may use your most comparable tractor model with our prior approval. In the case of alternate methods other than those specified in this subpart, good engineering judgment may require you to determine your adjustment factor based on results from more than one vehicle.

(3) For Phase 2 testing, determine separate values of $F_{alt\text{-}aero}$ for a high-roof day cab and a high-roof sleeper cab corresponding to each major tractor model based on testing as described in paragraph (b)(2) of this section. Perform this testing on each major tractor model. You may ask us to approve aggregating separate product lines into a single major tractor model if you show that the product lines are different only in ways that are unrelated to aerodynamic characteristics. If you have more than six major tractor models, you may limit

your testing in a given year to a maximum of six major tractor models until you have performed testing for your whole product line. For any untested tractor models, apply the value of $F_{alt\text{-}aero}$ from the tested tractor model that best represents the aerodynamic characteristics of the untested tractor model, consistent with good engineering judgment. Testing under this paragraph (b)(3) continues to be valid for later model years until you change the tractor model in a way that causes the test results to no longer represent production vehicles. You must also determine unique values of $F_{alt\text{-}aero}$ for low-roof and mid-roof tractors if you determine C_DA values based on low or mid-roof tractor testing as shown in Table 4 of § 1037.520. For Phase 1 testing, if good engineering judgment allows it, you may calculate a single, constant value of $F_{alt\text{-}aero}$ for your whole product line by dividing the coastdown drag area, C_DA_{coast}, by C_DA_{alt}.

(4) Calculate $F_{alt\text{-}aero}$ to at least three decimal places. For example, if your coastdown testing results in a drag area of 6.430, but your wind tunnel method results in a drag area of 6.200, $F_{alt\text{-}aero}$ would be 1.037.

(c) *Approval of alternative methods.* You must obtain preliminary approval before using any method other than coastdown testing to determine drag coefficients. We will approve your request if you show that your procedures produce data that are the same as or better than coastdown testing with respect to repeatability and unbiased correlation. Note that the correlation is not considered to be biased if there a bias before correction, but you remove the bias using $F_{alt\text{-}aero}$. Send your request for approval to the Designated Compliance Officer. Keep records of the information specified in this paragraph (c). Unless we specify otherwise, include this information with your request. You must provide any information we require to evaluate whether you may apply the provisions of this section, consistent with good engineering judgment. Include additional information related to your alternative method as described in §§ 1037.529 through 1037.533. If you use a method other than those specified in this subpart, include all the following information, as applicable:

(1) Official name/title of the procedure.

(2) Description of the procedure.

(3) Cited sources for any standardized procedures that the method is based on.

(4) Description and rationale for any modifications/deviations from the standardized procedures.

(5) Data comparing the procedure to the coastdown reference procedure.

(6) Additional information specified for the alternative methods described in §§ 1037.529 through 1037.533 as applicable to this method (*e.g.,* source location/address, background/history).

(d) *Yaw sweep corrections.* Aerodynamic features can be more effective at reducing wind-averaged drag than is predicted by zero-yaw drag. The following procedures describe how to adjust a tractor's C_DA values to account for wind-averaged drag:

(1) For Phase 2 testing, apply the following method based on SAE J1252 (incorporated by reference in § 1037.810):

(i) Determine the zero-yaw drag area, $C_DA_{zero\text{-}yaw}$, and the yaw-sweep drag area for your vehicle using the same alternate method. For the yaw sweep drag area, measure the drag area, at a minimum, at yaw angles of 0°, ±1°, ±3°, ±6°, and ±9°, where 0° represents the direction of travel. Alternatively, using good engineering judgment with demonstration of equivalency and our prior approval, you may measure the drag area using different or fewer yaw angles than those specified above, provided they satisfy the requirements for SAE J1252, unless otherwise demonstrated.

(ii) Calculate the wind-averaged coefficient of drag according to SAE J1252 based on a vehicle speed of 55 mph and a wind speed of 7 mph.

(iii) For the tractor used to determine $F_{alt\text{-}aero}$, determine your wind-averaged drag area, C_DA_{wa}, using the following equation:

$$C_DA_{wa} = C_DA_{zero\text{-}coastdown} + (C_DA_{wa\text{-}alt} - C_DA_{zero\text{-}alt}) \cdot F_{alt\text{-}aero} \qquad \text{Eq. 1037.525-2}$$

(iv) For additional tractors using an alternative method and predetermined $F_{alt\text{-}aero}$, use the following equation to determine C_DA_{wa}:

$$C_DA_{wa} = C_DA_{wa\text{-}alt} \cdot F_{alt\text{-}aero} \qquad \text{Eq. 1037.525-3}$$

(v) You may calculate C_DA_{wa} without additional testing by adding 0.80 m² to $C_DA_{zero\text{-}coastdown}$ or using the following equation if you use an alternative method:

$$C_DA_{wa} = (C_DA_{zero\text{-}alt} \cdot F_{alt\text{-}aero}) + 0.80 \qquad \text{Eq. 1037.525-4}$$

(2) For Phase 1 testing, you may correct your zero-yaw drag area as follows if the ratio of the zero-yaw drag area divided by yaw-sweep drag area for your vehicle is greater than 0.8065 for ±6° yaw angle or 0.8330 for wind-averaged drag (which represents the ratios expected for a typical Class 8 high-roof sleeper cab):

(i) Determine the zero-yaw drag area, $C_DA_{zero\text{-}yaw}$, and the yaw-sweep drag area, $C_DA_{full\text{-}ys}$, for your vehicle using the same alternate method as specified in this subpart. Measure the drag area for 0°, –6°, and +6°. Use the arithmetic mean of the –6° and +6° drag areas as the ±6° drag area, $\overline{C_DA_{\pm 6}}$.

(ii) Calculate your yaw-sweep correction factor, CF_{ys}, using the following equation:

$$CF_{ys} = \frac{\overline{C_DA_{\pm 6}} \cdot 0.8065}{C_DA_{zero\text{-}yaw}} \qquad \text{Eq. 1037.525-5}$$

(iii) You may instead calculate the wind-averaged drag area according to SAE J1252 (incorporated by reference in § 1037.810) and substitute this value into Equation 1037.525–4 for the ±6° yaw-averaged drag area. If you choose to calculate the wind-averaged drag area according to SAE J1252, you may calculate your yaw-sweep correction factor, CF_{ys}, using Equation 1037.525–5 through model year 2017; otherwise use the following equation:

$$CF_{ys} = \frac{C_DA_{full\text{-}ys} \cdot 0.8330}{C_DA_{zero\text{-}yaw}} \qquad \text{Eq. 1037.525-6}$$

(iv) Calculate your corrected drag area for determining the aerodynamic bin by multiplying the measured zero-yaw drag area by CF_{ys} as determined using Equation 1037.525–5 or 1037.525–6, as applicable. You may apply the correction factor to drag areas measured using other procedures. For example, apply CF_{ys} to drag areas measured using the coastdown method. If you use an alternative method, apply an alternative correction, $F_{alt\text{-}aero}$, and calculate the final drag area using the following equation:

$$C_DA = F_{alt\text{-}aero} \cdot CF_{ys} \cdot C_DA_{zero\text{-}alt} \qquad \text{Eq. 1037.525-7}$$

(v) You may ask us to apply CF_{ys} to similar vehicles incorporating the same design features.

§ 1037.527 Coastdown procedures for calculating drag area (C_DA).

The coastdown procedures in this section describe how to calculate drag area, C_DA, for Phase 2 tractors and trailers, subject to the provisions of § 1037.525. Follow the provisions of Sections 1 through 9 of SAE J2263 (incorporated by reference in § 1037.810), with the following clarifications and exceptions:

(a) The terms and variables identified in this section have the meaning given in SAE J1263 (incorporated by reference in § 1037.810) and J2263 unless specified otherwise.

(b) To determine C_DA values for a tractor, perform coastdown testing with a tractor-trailer combination using the manufacturer's tractor and a standard trailer. To determine C_DA values for a trailer, perform coastdown testing with a tractor-trailer combination using a standard tractor. Prepare tractors and trailers for testing as follows:

(1) Install instrumentation for peforming the specified measurements.

(2) After adding vehicle instrumentation, verify that there is no brake drag or other condition that prevents the wheels from rotating freely. Do not apply the parking brake at any point between this inspection and the end of the measurement procedure.

(3) Install tires mounted on steel rims in a dual configuration (except for steer tires). The tires must—

(i) Be SmartWay-Verified or have a coefficient of rolling resistance at or below 5.1 kg/metric ton.

(ii) Have accumulated at least 2,175 miles but have no less than 50 percent of their original tread depth, as specified for truck cabs in SAE J1263 (incorporated by reference in § 1037.810).

(iii) Not be retreads or have any apparent signs of chunking or uneven wear.

(iv) Be size 295/75R22.5 or 275/80R22.5.

(v) Be inflated to the proper tire pressure as specified in Sections 6.6 and 8.1 of SAE J2263.

(4) Perform an inspection or wheel alignment for both the tractor and the trailer to ensure that wheel position is within the manufacturer's specifications.

(c) The test condition specifications described in Sections 7.1 through 7.4 of SAE J1263 apply, with the following exceptions and additional provisions:

(1) We recommend that you not perform coastdown testing if winds are expected to exceed 6.0 mph.

(2) Road grade may exceed 0.5%; however, the road grade for testing must not be excessive, considering factors such as coastdown effects and road safety standards.

(3) If road grade is greater than 0.02% over the length of the test surface, you must determine road grade as a function of distance along the length of the test surface and incorporate this into the

analysis. Use Section 11.5 of SAE J2263 to calculate the force due to grade.

(4) The road surface temperature must be at or below 50 °C. Use good engineering judgment to measure road surface temperature.

(d) C_DA calculations are based on measured speed values while the vehicles coasts down through a high-speed range from 70 down to 60 mph, and through a low-speed range from 25 down to 15 mph. Disable any vehicle speed limiters that prevent travel above 72 mph. If a vehicle cannot exceed 72 mph, adjust the high-speed range to include the highest achievable speed range as described in paragraph (g)(2) of this section. Measure vehicle speed at a minimum recording frequency of 10 Hz, in conjunction with time-of-day data. Determine vehicle speed using either of the following methods:

(1) *Complete coastdown runs.* Operate the vehicle at a top speed above 72 mph and allow the vehicle to coast down to 13 mph or lower. Collect data for the high-speed range over a test segment that includes speeds from 72 down to 58 mph, and collect data for the low-speed range over a test segment that includes speeds from 27 down to 13 mph. Perform a minimum of sixteen valid coastdown runs, eight in each direction.

(2) *Split coastdown runs.* Collect data during a high-speed coastdown while the vehicle coasts through a test segment that includes speeds from 72 mph down to 58 mph. Similarly, collect data during a low-speed coastdown while the vehicle coasts through a test segment that includes speeds from 27 mph down to 13 mph. Perform two to four high-speed coastdowns consecutively in one direction followed by the same number of low-speed coastdowns in the same direction, then perform that same number of measurements in the opposite direction. Repeat this process until you have performed twelve valid high-speed coastdowns and twelve valid low-speed coastdowns in each direction. You may not split runs as described in Section 9.3.1 of SAE J2263 except as allowed under this paragraph (d)(2).

(e) Measure wind speed, wind direction, air temperature, and air pressure at a minimum recording frequency of 1 Hz, in conjunction with time-of-day data. Use at least one stationary electro-mechanical anemometer and suitable data loggers meeting SAE J1263 specifications, subject to the following additional specifications for the anemometer placed along the test surface:

(1) You must start a coastdown measurement within 24 hours after running zero-wind and zero-angle calibrations.

(2) Place the anemometer at least 50 feet from the nearest tree and at least 25 feet from the nearest bush (or equivalent features). Position the anemometer adjacent to the test surface, near the midpoint of the length of the track, between 2.5 and 3.0 body widths from the expected location of the test vehicle's centerline as it passes the anemometer. Record the location of the anemometer along the test track, to the nearest 10 feet.

(3) Mount the anemometer at a height that is within 6 inches of half the test vehicle's body height.

(4) The height of vegetation surrounding the anemometer may not exceed 10% of the anemometer's mounted height, within a radius equal to the anemometer's mounted height.

(f) Measure air speed and air direction onboard the vehicle at a minimum recording frequency of 10 Hz, in conjunction with time-of-day data, using an anemometer and suitable data loggers that meet the requirements of Sections 5.4 and 5.5 of SAE J2263. Mount the anemometer 1 meter above the top of the leading edge of the trailer. Correct anemometer measurements using the wind speed and wind direction measurements described in paragraph (e) of this section as follows:

(1) Calculate arithmetic mean values for vehicle speed, air speed, wind speed, and wind direction in 5-mph vehicle speed increments for each coastdown. Include data from vehicle speeds between 60 and 25 mph if you collect data from complete coastdown runs. You may disregard data from an increment at the start or end of the coastdown run if it is less than 5 minutes.

(2) Calculate the theoretical air speed, $v_{air,th,}$ for each 5-mph increment using the following equation:

$$\overline{v}_{\text{air,th}} = \sqrt{\overline{w}^2 + \overline{v}^2 - \overline{v}\,\overline{w}\cos(\overline{\theta}_{\text{w}} + \theta_{\text{veh}})} \qquad \text{Eq. 1037.527-1}$$

Where:

$\overline{w}$ = the mean wind speed over each 5-mph increment.

$\overline{v}$ = the mean vehicle speed over each 5-mph increment.

$\overline{\theta}_w$ = the mean wind direction over each 5-mph increment. Let $\overline{\theta}_w = 0$ for air flow in the first travel direction, with values increasing counterclockwise. For example, if the vehicle starts by traveling eastbound, then $\overline{\theta}_w = 270°$ means a wind from the south.

$\overline{\theta}_{veh}$ = the vehicle direction. Use $\overline{\theta}_{veh} = 0°$ for travel in the first direction, and use $\overline{\theta}_{veh} = 180°$ for travel in the opposite direction.

(3) Perform a linear regression using paired values of $\overline{v}_{air,th}$ and measured air speed, $\overline{v}_{air,mess}$, from all 5-mph increments to determine the air-speed correction coefficients, α_0 and $\alpha_{1,}$ based on the following equation:

$$\overline{v}_{\text{air,th}} = \alpha_0 + \alpha_1 \cdot \overline{v}_{\text{air,meas}} \qquad \text{Eq. 1037.527-2}$$

(4) Correct each measured value of air speed using the following equation:

$$v_{\text{air}} = \alpha_0 + \alpha_1 \cdot v_{\text{air,meas}} \qquad \text{Eq. 1037.527-3}$$

(g) Determine drag area, C_DA, using the following procedure instead of what is specified in Section 10 of SAE J1263:

(1) Calculate the vehicle's effective mass, M_e, to account for rotational inertia by adding 56.7 kg to the measured vehicle mass, M, (in kg) for each tire making road contact.

(2) Operate the vehicle and collect data over the high-speed range and low-speed range as specified in paragraph (d)(1) or (d)(2) of this section. If a vehicle cannot exceed a maximum speed of 72 mph, establish an alternate high-speed range by fixing the high end of the high-speed range at 2 mph less than the vehicle's maximum speed, and fixing the low end of the high-speed range such that the high-speed range spans 10 mph; adjust the testing and calculation instructions in this paragraph (g) as needed to account for this alternate high-speed range.

(3) Calculate mean vehicle speed at each speed endpoint (70, 60, 25, and 15 mph) as follows:

(i) Calculate the mean vehicle speed (in m/s) to represent the starting point of each speed range as the arithmetic average of measured speeds throughout the speed interval defined as 2.00 mph above the nominal starting speed point to 2.00 mph below the nominal starting speed point, expressed to at least two decimal places. Determine the timestamp corresponding to the starting point of each speed range as the time midpoint of the ±2.00 mph speed interval.

(ii) Repeat the calculations described in paragraph (g)(3)(i) of this section corresponding to the endpoint speed (60 or 15 mph) to determine the time at which the vehicle reaches the ending speed, and the mean vehicle speed representing the endpoint of each speed range.

(iii) If you incorporate grade into your calculations, use the average values for the elevation and distance traveled over each interval.

(4) Calculate the road-load force, F, for each speed range using the following equation:

$$F = -M_e \cdot \frac{\bar{v}_{start} - \bar{v}_{end}}{\bar{t}_{start} - \bar{t}_{end}} + M \cdot a_g \cdot \frac{\bar{h}_{start} - \bar{h}_{end}}{\bar{D}_{start} - \bar{D}_{end}} - F_{axle} \qquad \text{Eq. 1037.527-4}$$

Where:

M_e = the vehicle's effective mass, in kg, expressed to at least one decimal place.

$\bar{v}$ = average vehicle speed, in m/s, at the start or end of each speed range, as described in paragraph (g)(3) of this section.

$\bar{t}$ = timestamp at which the vehicle reaches the starting or ending speed, in seconds, expressed to at least one decimal place.

M = the vehicle's measured mass, in kg, expressed to at least one decimal place.

$\bar{h}$ = average elevation at the start or end of each speed range, in m, expressed to at least two decimal places.

$\bar{D}$ = distance traveled on the road surface from a fixed reference location along the road to the start or end of each speed range, in m, expressed to at least one decimal place.

F_{axle} = an estimate of rear-axle losses. Use 200 N for the high-speed range and 100 N for the low-speed range.

a_g = acceleration of Earth's gravity, as described in 40 CFR 1065.630.

(5) If you perform high-speed and low-speed coastdowns as described in paragraph (d)(2) of this section, average the F values for each set of consecutive low-speed runs. Use this value as F_{lo} in the calculations in this paragraph (g) to apply to each of the high-speed runs in a set of consecutive high-speed runs that immediately precede a set of consecutive low-speed runs. Otherwise, determine the F_{lo} and F_{hi} values in the calculations in this paragraph (g) from the same run.

(6) Calculate average air temperature $\bar{T}$ and air pressure $\bar{p}_{act}$ during each high-speed run.

(7) Calculate average air speed during each speed range for each run, $\bar{v}_{air,hi}$ and $\bar{v}_{air,lo}$.

(8) Perform an iterative calculation to determine aerodynamic and mechanical forces as follows:

(i) Assume initially that aerodynamic forces for the low-speed range are zero: $F_{aero,lo} = 0$.

(ii) Estimate high-speed aerodynamic forces by subtracting mechanical forces from the road-load force corresponding to the high-speed coastdown, F_{hi}, as follows:

$$F_{aero,hi} = F_{hi} - (F_{lo} - F_{aero,lo}) \qquad \text{Eq. 1037.523-5}$$

(iii) Calculate a new value for $F_{aero,lo}$ by adjusting the high-speed aerodynamic forces to account for speed, as follows:

$$F_{aero,lo} = F_{aero,hi} \cdot \frac{\bar{v}^2_{air,lo}}{\bar{v}^2_{air,hi}} \qquad \text{Eq. 1037.527-6}$$

(iv) Repeat the steps in paragraphs (g)(8)(ii) and (iii) of this section until $F_{aero,hi}$ changes less than 1.0%.

(9) Calculate drag area, C_DA, in m² for each high-speed segment using the following equation:

$$C_DA = \frac{2 \cdot F_{aero,hi}}{\bar{v}^2_{air,hi}} \cdot \frac{R \cdot \bar{T}}{\bar{p}_{act}} \qquad \text{Eq. 1037.527-7}$$

Where:

R = specific gas constant = 287.058 J/(kg·K).

$\overline{T}$ = mean air temperature in K, expressed to at least one decimal place.

$\overline{P}_{act}$ = mean absolute air pressure in Pa, expressed to at least one decimal place.

(10) Calculate an arithmetic mean C_DA value from all the high-speed segments to determine the drag area for the test.

(h) Include the following information in your application for certification:

(1) The name, location, and description of your test facilities, including background/history, equipment and capability, and track and facility elevation, along with the grade and size/length of the track.

(2) Test conditions for each test result, including date and time, wind speed and direction, ambient temperature and humidity, vehicle speed, driving distance, manufacturer name, test vehicle/model type, model year, applicable family, tire type and rolling resistance, weight of tractor-trailer (as tested), and driver identifier(s).

(3) Average C_DA result and all the individual run results (including voided or invalid runs).

§ 1037.529 Wind-tunnel procedures for calculating drag area (C_DA).

(a) You may measure drag areas consistent with published SAE procedures as described in this section using any wind tunnel recognized by the Subsonic Aerodynamic Testing Association, subject to the provisions of § 1037.525. If your wind tunnel does not meet the specifications described in this section, you may ask us to approve it as an alternative method under § 1037.525(b). All wind tunnels must meet the specifications described in SAE J1252 (incorporated by reference in § 1037.810), with the following exceptions and additional provisions:

(1) The minimum Reynold's number, $Re^{\#}_{min}$, is $1.0 \cdot 10^6$ instead of the value specified in section 5.2 of SAE J1252. Also, the projected frontal area of the vehicle at zero yaw angle may exceed the recommended 5 percent of the active test section area, but it may not exceed 25 percent.

(2) For full-scale wind tunnel testing, use good engineering judgment to select a tractor and trailer that is a reasonable representation of the tractor and trailer used for eference coastdown testing. For example, where your wind tunnel is not long enough to test the tractor with a standard 53 foot trailer, it may be appropriate to use a shorter box trailer. In such a case, the correlation developed using the shorter trailer would only be valid for testing with the shorter trailer.

(3) For reduced-scale wind tunnel testing, use a one-eighth or larger scale model of a tractor and trailer that is sufficient to simulate airflow through the radiator inlet grill and across an engine geometry that represents engines commonly used in your test vehicle.

(b) Open-throat wind tunnels must also meet the specifications of SAE J2071 (incorporated by reference in § 1037.810).

(c) To determine C_DA values for a tractor, perform wind-tunnel testing with a tractor-trailer combination using the manufacturer's tractor and a standard trailer. To determine C_DA values for a trailer, perform wind-tunnel testing with a tractor-trailer combination using a standard tractor. The wind tunnel tests performed under this section must simulate a vehicle speed of 55 mph. For Phase 1 vehicles, conduct the wind tunnel tests at a zero yaw angle and, if so equipped, utilizing the moving/rolling floor to simulate driving the vehicle for comparison to the coastdown procedure, which corrects to a zero yaw angle for the oncoming wind. For Phase 2 vehicles, conduct the wind tunnel tests by measuring the drag area according to § 1037.525(d)(1) and, if so equipped, utilizing the moving/rolling floor for comparison to the coastdown procedure.

(d) In your request to use wind-tunnel testing, describe how you meet all the specifications that apply under this section, using terminology consistent with SAE J1594 (incorporated by reference in § 1037.810). If you request our approval to use wind-tunnel testing even though you do not meet all the specifications of this section, describe how your method nevertheless qualifies as an alternative method under § 1037.525(c) and include all the following information:

(1) Identify the name and location of the test facilities for your wind tunnel method.

(2) Background and history of the wind tunnel.

(3) The wind tunnel's layout (with diagram), type, and construction (structural and material).

(4) The wind tunnel's design details: The type and material for corner turning vanes, air settling specification, mesh screen specification, air straightening method, tunnel volume, surface area, average duct area, and circuit length.

(5) Specifications related to the wind tunnel's flow quality: Temperature control and uniformity, airflow quality, minimum airflow velocity, flow uniformity, angularity and stability, static pressure variation, turbulence intensity, airflow acceleration and deceleration times, test duration flow quality, and overall airflow quality achievement.

(6) Test/working section information: Test section type (*e.g.,* open, closed, adaptive wall) and shape (*e.g.,* circular, square, oval), length, contraction ratio, maximum air velocity, maximum dynamic pressure, nozzle width and height, plenum dimensions and net volume, maximum allowed model scale, maximum model height above road, strut movement rate (if applicable), model support, primary boundary layer slot, boundary layer elimination method, and photos and diagrams of the test section.

(7) Fan section description: Fan type, diameter, power, maximum rotational speed, maximum speed, support type, mechanical drive, and sectional total weight.

(8) Data acquisition and control (where applicable): Acquisition type, motor control, tunnel control, model balance, model pressure measurement, wheel drag balances, wing/body panel balances, and model exhaust simulation.

(9) Moving ground plane or rolling road (if applicable): Construction and material, yaw table and range, moving ground length and width, belt type,

maximum belt speed, belt suction mechanism, platen instrumentation, temperature control, and steering.

(10) Facility correction factors and purpose.

§ 1037.531 Using computational fluid dynamics to calculate drag area (C_DA).

This section describes how to use commercially available computational fluid dynamics (CFD) software to determine C_DA values, subject to the provisions of § 1037.525.

(a) To determine C_DA values for a tractor, perform CFD modeling based on a tractor-trailer combination using the manufacturer's tractor and a standard trailer. To determine C_DA values for a trailer, perform CFD modeling based on a tractor-trailer combination using a standard tractor. Perform all CFD modeling as follows:

(1) Except as described in paragraph (a)(9) of this section, specify a blockage ratio at or below 0.2 percent to simulate open-road conditions.

(2) Specify yaw angles according to § 1037.525(d)(1) for Phase 2 vehicles; assume zero yaw angle for Phase 1 vehicles.

(4) Model the tractor with an open grill and representative back pressures based on available data describing the tractor's pressure characteristics.

(5) Enable the turbulence model and mesh deformation.

(6) Model tires and ground plane in motion to simulate a vehicle moving forward in the direction of travel.

(7) Apply the smallest cell size to local regions on the tractor and trailer in areas of high flow gradients and smaller-geometry features (*e.g.,* the A-pillar, mirror, visor, grille and accessories, trailer-leading edge, trailer-trailing edge, rear bogey, tires, and tractor-trailer gap).

(8) Simulate a vehicle speed of 55 mph.

(b) Take the following steps for CFD code with a Navier-Stokes formula solver:

(1) Perform an unstructured, time-accurate analysis using a mesh grid size with a total volume element count of at least 50 million cells of hexahedral and/or polyhedral mesh cell shape, surface elements representing the geometry consisting of no less than 6 million elements, and a near-wall cell size corresponding to a y+ value of less than 300.

(2) Perform the analysis with a turbulence model and mesh deformation enabled (if applicable) with boundary layer resolution of ±95 percent. Once the results reach this resolution, demonstrate the convergence by supplying multiple, successive convergence values for the analysis. The turbulence model may use k-epsilon (k-ε), shear stress transport k-omega (SST k-ω), or other commercially accepted methods.

(c) For Lattice-Boltzman based CFD code, perform an unstructured, time-accurate analysis using a mesh grid size with total surface elements of at least 50 million cells using cubic volume elements and triangular and/or quadrilateral surface elements with a near-wall cell size of no greater than 6 mm on local regions of the tractor and trailer in areas of high flow gradients and smaller geometry features, with cell sizes in other areas of the mesh grid starting at twelve millimeters and increasing in size from this value as the distance from the tractor and trailer increases.

(d) You may ask us to allow you to perform CFD analysis using parameters and criteria other than those specified in this section, consistent with good engineering judgment. In your request, you must demonstrate that you are unable to perform modeling based on the specified conditions (for example, you may have insufficient computing power, or the computations may require inordinate time), or you must demonstrate that different criteria (such as a different mesh cell shape and size) will yield better results. In your request, you must also describe your recommended alternative parameters and criteria, and describe how this approach will produce results that adequately represent a vehicle's in-use performance. We may require that you supply data demonstrating that your selected parameters and criteria will provide a sufficient level of detail to yield an accurate analysis. If you request an alternative approach because it will yield better results, we may require that you perform CFD analysis using both your recommended criteria and parameters and the criteria and parameters specified in this section to compare the resulting key aerodynamic characteristics, such as pressure profiles, drag build-up, and turbulent/laminar flow at key points around the tractor-trailer combination.

(e) Include the following information in your request to determine C_DA values using CFD for tractors:

(1) The name of the software.

(2) The date and version number of the software.

(3) The name of the company producing the software and the corresponding address, phone number, and Web site.

(4) Identify whether the software uses Navier-Stokes or Lattice-Boltzmann equations.

(5) Describe the input values you will use to simulate the vehicle's aerodynamic performance for comparing to coastdown results.

§ 1037.533 Constant-speed procedure for calculating drag area (C_DA).

This section describes how to use constant-speed aerodynamic drag testing to determine C_DA values, subject to the provisions of § 1037.525.

(a) *Test track.* Select a test track that meets the specifications described in § 1037.527(c)(2).

(b) *Ambient conditions.* Ambient conditions must remain within the specifications described in § 1037.527(c) throughout the preconditioning and measurement procedure.

(c) *Vehicle preparation.* To determine C_DA values for a tractor, perform coastdown testing with a tractor-trailer combination using the manufacturer's tractor and a standard trailer. To determine C_DA values for a trailer, perform coastdown testing with a tractor-trailer combination using a standard tractor. Prepare tractors and trailers for testing as described in § 1037.527(b). Install measurement instruments meeting the requirements of 40 CFR part 1065, subpart C, that have been calibrated as described in 40 CFR part 1065, subpart D, as follows:

(1) Install a torque meter to measure torque at the vehicle's driveshaft, or measure torque from both sides of each drive axle using a half-shaft torque meter, a hub torque meter, or a rim torque meter. Set up instruments to read engine rpm for calculating rotational speed at the point of the torque measurements, or install instruments for measuring the rotational speed of the driveshaft, axles, or wheels directly.

(2) Install instrumentation to measure vehicle speed at 10 Hz, with an accuracy and resolution of 0.2 kph. Also install instrumentation for reading engine rpm from the engine's onboard computer.

(3) Mount an anemometer on the trailer as described in § 1037.527(f). For air speeds in the range of 65–130 kps and yaw angles in the range of 0±7°, the anemometer must have an accuracy that is ±1.5% of measured air speed and is ±0.5° of measured yaw angle.

(4) Fill the vehicle's fuel tanks to be at maximum capacity at the start of the measurement procedure.

(5) Measure total vehicle mass to the nearest 20 kg, with a full fuel tank, including the driver and any passengers that will be in the vehicle during the measurement procedure.

(d) *Measurement procedure.* The measurement sequence consists of vehicle preconditioning followed by stabilization and measurement over five consecutive constant-speed test segments with three different speed setpoints (16, 80, and 113 kph). Each test segment is divided into smaller increments for data analysis.

(1) Precondition the vehicle and zero the torque meters as follows:

(i) If you are using rim torque meters, zero the torque meters by lifting each instrumented axle and recording torque signals for at least 30 seconds, and then drive the vehicle at 80 kph for at least 30 minutes.

(ii) If you are using any other kind of torque meter, drive the vehicle at 80 kph for at least 30 minutes, and then allow the vehicle to coast down from full speed to a complete standstill while the clutch is disengaged or the transmission is in neutral, without braking. Zero the torque meters within 60 seconds after the vehicle stops moving by recording the torque signals for at least 30 seconds, and directly resume vehicle preconditioning at 80 kph for at least 2 km.

(iii) You may calibrate instruments during the preconditioning drive.

(2) Perform testing as described in paragraph (d)(3) of this section over a sequence of test segments at constant vehicle speed as follows:

(i) 300±30 seconds in each direction at 16 kph.

(ii) 450±30 seconds in each direction at 80 kph.

(iii) 900±30 seconds in each direction at 113 kph.

(iv) 450±30 seconds in each direction at 80 kph.

(v) 300±30 seconds in each direction at 16 kph.

(3) When the vehicle preconditioning described in paragraph (d)(1) of this section is complete, stabilize the vehicle at the specified speed for at least 200 meters and start taking measurements. The test segment starts when you start taking measurements for all parameters.

(4) During the test segment, continue to operate the vehicle at the speed setpoint, maintaining constant speed and torque within the ranges specified in paragraph (e) of this section. Drive the vehicle straight with minimal steering; do not change gears. Perform measurements as follows during the test segment:

(i) Measure the rotational speed of the driveshaft, axle, or wheel where the torque is measured, or calculate it from engine rpm in conjunction with gear and axle ratios, as applicable.

(ii) Measure vehicle speed in conjunction with time-of-day data.

(iii) Measure ambient conditions, air speed, and air direction as described in § 1037.527(e) and (f). Correct air speed and air direction as described in paragraphs (f)(1) and (2) of this section.

(5) You may divide a test segment into multiple passes by suspending and resuming measurements. Stabilize vehicle speed before resuming measurements for each pass as described in paragraph (d)(3) of this section. Analyze the data from multiple passes by combining them into a single sequence of measurements for each test segment.

(6) Divide measured values into even 10-second increments. If the last increment for each test segment is less than 10 seconds, disregard measured values from that increment for all calculations under this section.

(e) *Validation criteria.* Analyze measurements to confirm that the test is valid. Analyze vehicle speed and drive torque by calculating the mean speed and torque values for each successive 1-second increment, for each successive 10-second increment, and for each test segment. The test is valid if the data conform to all the following specifications:

(1) *Vehicle speed.* The mean vehicle speed for the test segment must be within 2.0 kph of the speed setpoint. In addition, for testing at 80 kph and 113 kph, all ten of the 1-second mean vehicle speeds used to calculate a corresponding 10-second mean vehicle speed must be within ± 0.3 kph of that 10-second mean vehicle speed. Perform the same data analysis for testing at 16 kph, but apply a validation threshold of ±0.15 kph.

(2) *Drive torque.* All ten of the 1-second mean torque values used to calculate a corresponding 10-second mean torque value must be within ±10% of that 10-second mean torque value.

(3) *Torque drift.* Torque meter drift may not exceed ±1%. Determine torque meter drift by repeating the procedure described in paragraph (d)(1) of this section after testing is complete, except that driving the vehicle is necessary only to get the vehicle up to 80 kph as part of coasting to standstill.

(f) *Calculations.* Analyze measured data for each time segment after time-aligning all the data. Use the following calculations to determine C_DA:

(1) *Onboard air speed.* Correct onboard anemometer measurements for air speed using onboard measurements and measured ambient conditions as described in § 1037.527(f), except that you must divide the test segment into consecutive 10-second increments rather than 5-mph increments. Disregard data from the final increment of the test segment if it is less than 10 seconds. This analysis results in the following equation for correcting air speed measurements:

$$v_{\text{air}} = \alpha_0 + \alpha_1 \cdot v_{\text{air,meas}} \qquad \text{Eq. 1037.533-1}$$

(2) *Yaw angle.* Correct the onboard anemometer measurements for air direction for each test segment as follows:

(i) Calculate arithmetic mean values for air speed, $\bar{v}_{\text{air}}$, wind speed, $\bar{\theta}_{\text{w}} = 0$, and wind direction, $\bar{w}$, over each 10-second increment for each test segment. Disregard data from the final increment of the test segment if it is less than 10 seconds.

(ii) Calculate the theoretical air direction, $\theta_{\text{air,th}}$, for each 10-second increment using the following equation:

$$\bar{\theta}_{\text{air,th}} = -\text{asin}\left(\frac{\bar{w}}{\bar{v}_{\text{air}}} \cdot \sin\left(\bar{\theta}_{\text{w}} + \theta_{\text{veh}}\right)\right) \qquad \text{Eq. 1037.533-2}$$

Where:

θ_{veh} = the vehicle direction, as described in § 1037.527(f)(2).

(iii) Perform a linear regression using paired values of $\theta_{\text{air,th}}$ and measured air direction, $\theta_{\text{air,meas}}$, from each 10-second increment for all 80 kph and 113 kph test segments to determine the air-direction correction coefficients, β_0 and β_1, based on the following equation:

$$\overline{\theta}_{\text{air,th}} = \beta_0 + \beta_1 \cdot \overline{\theta}_{\text{air,meas}} \qquad \text{Eq. 1037.533-3}$$

(iv) For all 80 kph and 113 kph test segments, correct each measured value of air direction using the following equation:

$$\theta_{\text{air}} = \beta_0 + \beta_1 \cdot \theta_{\text{air,meas}} \qquad \text{Eq. 1037.533-4}$$

(3) *Traction force.* (i) Calculate a traction force in N for each measurement using the following equation:

$$F_{\text{trac}} = \frac{T_{\text{total}}}{v_{\text{veh}}} \cdot \frac{n_{\text{eng}} \cdot \pi}{k_{\text{g}} \cdot k_{\text{a}} \cdot 30} - M \cdot a_{\text{g}} \cdot \frac{G}{100}$$

Where:

T_{total} = the sum of all corrected torques at a point in time, in N·m.
v_{veh} = vehicle speed in m/s (full precision).
n_{eng} = mean engine speed in rpm (full precision).
k_{g} = transmission gear ratio of the engaged gear.
k_{a} = drive axle ratio.
M = the measured vehicle mass, in kg
a_{g} = acceleration of Earth's gravity, as described in 40 CFR 1065.630.
G = instantaneous road grade, in percent (increase in elevation per 100 units horizontal length).

(ii) Calculate a mean traction force, $\overline{F}_{\text{trac}}$, in N for each 10-second increment by averaging all the calculated traction forces in each 10-second increment.

(4) *Determination of drag area.* Calculate a vehicle's drag area as follows:

(i) Use Equation 1037.533–5 to calculate a single mean traction force for the two 16-kph test segments, $\overline{F}_{\text{trac16}}$. This value represents the mechanical drag force acting on the vehicle.

(ii) Calculate the mean aerodynamic force for each 10-second increment, $\overline{F}_{\text{aero}}$, from the 80 kph and 113 kph test segments by subtracting $\overline{F}_{\text{trac16}}$ from $\overline{F}_{\text{trac}}$.

(iii) Average the corrected air speed and corrected yaw angle over every 10-second segment from the 80 kph and 113 kph test segments to determine $\overline{v}_{\text{air}}$ and θ_{air}.

(iv) Calculate C_DA for each 10-second increment from the 80 kph and 113 kph test segments using the following equation:

$$C_DA_i = \left[\frac{2 \cdot \overline{F}_{\text{aero}}}{\overline{v}^2_{\text{air}}} \cdot \frac{R \cdot \overline{T}}{\overline{p}_{\text{act}}} \right]_i \qquad \text{Eq. 1037.533-6}$$

Where:

C_DA_i = the mean drag area for each 10-second increment, *i*.
$\overline{F}_{\text{aero}}$ = mean aerodynamic force over a given 10-second increment.
$\overline{V}^2_{\text{air[speed]}}$ = mean aerodynamic force over a given 10-second increment
R = specific gas constant = 287.058 J/(kg·K).
$\overline{T}$ = mean air temperature in K.
$\overline{P}_{\text{act}}$ = mean absolute air pressure in Pa.

(v) Determine whether at least 75 percent of the 10-second increments from the 80 kph and 113 kph test segments have a corrected yaw angle, θ_{air}, that is within the range of $|\theta_{\text{air}}| \leq 2°$. If so, this is considered a low-yaw test. If not, this is considered a high-yaw test.

(vi) For low-yaw tests, calculate a vehicle's characteristic zero-yaw drag area as the arithmetic mean of the drag areas representing all the 10-second increments for both 80 kph and 113 kph test segments that had.

(vii) For high-yaw tests, calculate a vehicle's characteristic zero-yaw drag area as follows:

(A) Plot all the C_DA values from the 80 kph and 113 kph test segments against the corresponding values for corrected yaw angle for each 10-second increment. Create a regression based on a fourth-order polynomial regression equation of the following form:

$$C_DA = C_DA_{\text{ZeroYaw}} + \text{a}_1\,\overline{\theta}_{\text{air}} + \text{a}_2\,\overline{\theta}^2_{\text{air}} + \text{a}_3\,\overline{\theta}^3_{\text{air}} + \text{a}_4\,\overline{\theta}^4_{\text{air}} \qquad \text{Eq. 1037.533-7}$$

(B) Determine $C_DA_{\text{zero-yaw}}$ as the y-intercept from the regression equation.

(g) *Documentation.* Keep the following records related to the constant-speed procedure for calculating drag area:

(1) The measurement data for calculating C_DA as described in this section.

(2) A general description and pictures of the vehicle tested.

(3) The vehicle's maximum height and width.

(4) The measured vehicle mass.

(5) Mileage at the start of the first test segment and at the end of the last test segment.

(6) The date of the test, the starting time for the first test segment, and the ending time for the last test segment.

(7) The transmission gear used for each test segment.

(8) The data describing how the test was valid relative to the specifications and criteria described in paragraphs (b) and (e) of this section.

(9) A description of any unusual events, such as a vehicle passing the test vehicle, or any technical or human errors that may have affected the C_DA determination without invalidating the test.

§ 1037.540 Special procedures for testing vehicles with hybrid power take-off.

This section describes the procedure for quantifying the reduction in greenhouse gas emissions for vehicles as a result of running power take-off (PTO) devices with a hybrid energy delivery system. The procedures are written to test the PTO by ensuring that the engine produces all of the energy with no net change in stored energy. The full test for the hybrid vehicle is from a fully charged renewable energy storage system (RESS) to a depleted RESS and then back to a fully charged RESS. The procedures in paragraphs (a) though (e) of this section may be used for Phase 1 testing of any hybrid PTO architecture for which you are requesting a vehicle certificate using either chassis testing or powertrain testing. You must include all hardware for the PTO system. You may ask us to modify the provisions of this section to allow testing hybrid vehicles other than electric-battery hybrids, consistent with good engineering judgment. Phase 2 PTO greenhouse gas emission reductions are quantified using GEM and are described in paragraph (f) of this section.

(a) Select two vehicles for testing as follows:

(1) Select a vehicle with a hybrid energy delivery system to represent the vehicle family. If your vehicle family includes more than one vehicle model, use good engineering judgment to select the vehicle type with the maximum number of PTO circuits that has the smallest potential reduction in greenhouse gas emissions.

(2) Select an equivalent conventional vehicle as specified in § 1037.615.

(b) Measure PTO emissions from the fully warmed-up conventional vehicle as follows:

(1) Without adding a restriction, instrument the vehicle with pressure transducers at the outlet of the hydraulic pump for each circuit. Perform pressure measurements with a frequency of at least 1 Hz.

(2) Operate the PTO system with no load for at least 15 seconds. Measure gauge pressure and record the average value over the last 10 seconds ($\overline{P}_{\min}$). Apply maximum operator demand to the PTO system until the pressure relief valve opens and pressure stabilizes; measure gauge pressure and record the average value over the last 10 seconds ($\overline{P}_{\max}$).

(3) Denormalize the PTO duty cycle in Appendix II of this part using the following equation:

$$p_{\text{refi}} = p_{\text{i}} \cdot \left(\overline{p}_{\max} - \overline{p}_{\min} \right) + \overline{p}_{\min} \quad \text{Eq. 1037.540-1}$$

Where:

p_{refi} = the reference pressure at each point i in the PTO cycle.

p_{i} = the normalized pressure at each point i in the PTO cycle (relative to $\overline{p}_{\max}$).

$\overline{p}_{\max}$ = the mean maximum pressure measured in paragraph (b)(2) of this section.

$\overline{p}_{\min}$ = the mean minimum pressure measured in paragraph (b)(2) of this section.

(4) If the PTO system has two circuits, repeat paragraph (b)(2) and (3) of this section for the second PTO circuit.

(5) Install a system to control pressures in the PTO system during the cycle.

(6) Start the engine.

(7) Operate the vehicle over one or both of the denormalized PTO duty cycles in Appendix II of this part, as applicable. Measure emissions during operation over each duty cycle using the provisions of 40 CFR part 1066.

(8) Measured pressures must meet the cycle-validation specifications in the following table for each test run over the duty cycle:

TABLE 1 OF § 1037.540—STATISTICAL CRITERIA FOR VALIDATING EACH TEST RUN OVER THE DUTY CYCLE

Parameter [a]	Pressure
Slope, a_1	$0.950 \leq a_1 \leq 1.030$
Absolute value of intercept, $\lvert a_0 \rvert$.	≤2.0% of maximum mapped pressure
Standard error of estimate, *SEE*.	≤10% of maximum mapped pressure
Coefficient of determination, r^2.	≥ 0.970

[a] Determine values for specified parameters as described in 40 CFR 1065.514(e) by comparing measured values to denormalized pressure values from the duty cycle in Appendix II of this part.

(c) Measure PTO emissions from the fully warmed-up hybrid vehicle as follows:

(1) Perform the steps in paragraphs (b)(1) through (5) of this section.

(2) Prepare the vehicle for testing by operating it as needed to stabilize the battery at a full state of charge. For electric hybrid vehicles, we recommend running back-to-back PTO tests until engine operation is initiated to charge the battery. The battery should be fully charged once engine operation stops. The ignition should remain in the ''on'' position.

(3) Turn the vehicle and PTO system off while the sampling system is being prepared.

(4) Turn the vehicle and PTO system on such that the PTO system is functional, whether it draws power from the engine or a battery.

(5) Operate the vehicle over one or both of the denormalized PTO duty cycles without turning the vehicle off, until the engine starts and then shuts down. The test cycle is completed once the engine shuts down. Measure emissions as described in paragraph (b)(7) of this section. Use good engineering judgment to minimize the variability in testing between the two types of vehicles.

(6) Apply cycle-validation criteria as described in paragraph (b)(8) of this section.

(d) Calculate the equivalent distance driven based on operating time for the PTO portion of the test by determining the time of the test and applying the conversion factor in paragraph (d)(4) of this section. For testing where fractions of a cycle were run (for example, where three cycles are completed and the halfway point of a fourth PTO cycle is reached before the engine starts and shuts down again), calculate the time of the test, t_{test}, as follows:

(1) Add up the time run for all complete tests.

(2) For fractions of a test, use the following equation to calculate the time:

$$t_{\text{test-partial}} = \frac{\sum_{i=1}^{N}\left(p_{\text{circuit-1,i}} + p_{\text{circuit-2,i}}\right)\cdot \Delta t}{\overline{p}_{\text{circuit-1}} + \overline{p}_{\text{circuit-2}}} \quad \text{Eq. 1037.540-2}$$

Where:

i = an indexing variable that represents one recorded value.

N = number of measurement intervals.

$p_{\text{circuit-1}}$ = normalized pressure command from circuit 1 of the PTO cycle for each point, i, starting from i = 1.

$p_{\text{circuit-2}}$ = normalized pressure command from circuit 2 of the PTO cycle for each point, i, starting from i = 1. Let $p_{\text{circuit-2}}$ = 0 if there is only one circuit.

$\overline{P}_{\text{circuit-1}}$ = the mean normalized pressure command from circuit 1 over the entire PTO cycle.

$\overline{P}_{\text{circuit-2}}$ = the mean normalized pressure command from circuit 2 over the entire PTO cycle. Let $\overline{P}_{\text{circuit-2}}$ = 0 if there is only one circuit.

Δt = the time interval between measurements. For example, at 100 Hz, Δt = 0.0100 seconds.

(3) Sum the time from the complete cycles and from the partial cycle.

(4) Divide the total PTO operating time from paragraph (d)(3) of this section by a conversion factor of 0.0144 hr/mi to determine the equivalent distance driven. This is based on an assumed fraction of engine operating time during which the PTO is operating of 28 percent, and an assumed average vehicle speed while driving of 27.1 mph, as follows:

$$Factor = \frac{28\%}{(100\% - 28\%)\cdot 27.1} = 0.0144 \text{ hr/mi}$$

(e) For Phase 1, calculate combined cycle-weighted emissions of the four duty cycles for vocational vehicles, for both the conventional and hybrid PTO vehicle tests, as follows:

(1) Calculate the CO_2 emission rates in grams per test without rounding.

(2) Divide the CO_2 mass from the PTO cycle by the distance determined in paragraph (d)(4) of this section and the standard payload to get the CO_2 emission rate in g/ton-mile.

(3) Calculate the g/ton-mile emission rate for the driving portion of the test specified in § 1037.510 and add this to the CO_2 g/ton-mile emission rate for the PTO portion of the test.

(4) Follow the provisions of § 1037.615 to calculate improvement factors and benefits for advanced technologies.

(f) For Phase 2, calculate the delta PTO fuel results for input into GEM during vehicle certification as follows:

(1) Calculate fuel consumption in grams per test, m_{fuelPTO}, without rounding, as described in § 1037.550(k)(1).

(2) Divide the fuel mass by the distance determined in paragraph (d)(4) of this section and the standard payload to determine the fuel rate in g/ton-mile.

(3) Calculate the difference between the conventional PTO emissions result and the hybrid PTO emissions result for input into GEM.

(g) If the PTO system has more than two circuits, apply to provisions of this section using good engineering judgment.

§ 1037.550 Powertrain testing.

This section describes the procedure for simulating a chassis test for both conventional and hybrid powertrains. This testing is an optional approach that replaces the fuel map in GEM for certifying Phase 2 vehicles. It applies for vehicle manufacturers, but engine manufacturers may perform testing under this section as specified in 40 CFR 1036.630 and § 1037.551. While this section includes the detailed equations, you need to develop your own driver model and vehicle model; we recommend that you use the MATLAB/Simulink code provided at *www.epa.gov/otaq/climate/gem.htm*.

(a) Perform the powertrain test to establish measured fuel-consumption rates at a range of engine speed and load settings. Also measure NO_X emissions during each of the specified sampling periods consistent with the data requirements 40 CFR part 86, subpart T. You may use emission-measurement systems meeting the specifications of 40 CFR part 1065, subpart J, to measure NOx emissions. This section uses engine parameters and variables that are consistent with 40 CFR part 1065. For molar mass values, see 40 CFR 1065.1005(f)(2).

(b) Select fuel-consumption rates (g/cycle) to characterize the powertrain emissions at each setting. These declared values may not be lower than any corresponding measured values determined in this section. You may select any value that is at or above the corresponding measured value. These declared fuel-consumption rates serve as worst-case values for certification.

(c) Select a test engine and powertrain as described in § 1037.235.

(d) Set up the engine according to 40 CFR 1065.110. The default test configuration involves connecting the powertrain's transmission output shaft directly to the dynamometer. You may instead set up the dynamometer to connect at the wheel hubs if your powertrain configuration requires it, such as for hybrid powertrains, or if you want to represent the axle performance with powertrain test results. If you connect at the wheel hubs, input your test results into GEM to reflect this.

(e) Cool the powertrain during testing so temperatures for intake-air, oil, coolant, block, head, transmission, battery, and power electronics are within their expected ranges for normal operation. You may use auxiliary coolers and fans.

(f) Set the dynamometer to operate in speed control. Record data as described in 40 CFR 1065.202. Design a vehicle model to measure torque and calculate the dynamometer speed setpoint at a rate of at least 100 Hz, as follows:

(1) Calculate the dynamometer's angular speed target, $f_{\text{nref,dyno}}$, based on the simulated linear speed of the tires:

$$f_{\text{nrefi,dyno}} = \frac{k_a}{2 \cdot \pi \cdot r} \cdot v_{\text{refi}} \qquad \text{Eq. 1037.550-1}$$

Where:

$$r_{[\text{speed}]} = \text{tire radius} = \frac{k_a \cdot k_{\text{topgear}} \cdot v_{65}}{2 \cdot \pi \cdot f_{\text{n[speed]}}} \qquad \text{Eq. 1037.550-2}$$

k_a = drive axle ratio. Set k_a = 4.0 for all calculations in this paragraph (f).
$k_{topgear}$ = transmission gear ratio in the highest available gear.

v_{65} = reference speed. Use 65 mph = 29.05 m/s.

$f_{n[speed]}$ = engine's angular speed determined in paragraph (h) of this section.

$$v_{\text{refi}} = \left(\begin{array}{l} \dfrac{k_d \cdot T_{\text{i-1}}}{r} \cdot \left(Eff_{\text{axle}}\right) - \\ \left(M \cdot g \cdot C_{\text{rr}} \cdot \cos\left(\text{atan}\left(G_{\text{i-1}}\right)\right) + \dfrac{\rho \cdot C_D A}{2} \cdot v^2_{\text{ref,i-1}} \right) - F_{\text{brake,i-1}} - F_{\text{grade,i-1}} \end{array} \right) \cdot \frac{\Delta t_{\text{i-1}}}{M + M_{\text{rotating}}} + v_{\text{ref,i-1}} \qquad \text{Eq. 1037.550-3}$$

Where:
v_{refi} = simulated vehicle reference speed. Use the unrounded result for calculating $f_{nrefi,dyno}$.
i = a time-based counter corresponding to each measurement during the sampling period. Let v_{ref1} = 0; start calculations at i = 2. A 10-minute sampling period will generally involve 60,000 measurements.
T = instantaneous measured torque.
Eff_{axle} = axle efficiency. Use Eff_{axle} = 0.955 for $T > 0$, and use Eff_{axle} = 1/0.955 for $T < 0$. To calculate $f_{nrefi,dyno}$ for a dynamometer connected at the wheel hubs, as described in paragraph (f)(2) of this section, use Eff_{axle} = 1.0.
M = vehicle mass for a vehicle class as determined in paragraph (h) of this section.
g = gravitational constant = 9.81 m/s^2.
C_{rr} = coefficient of rolling resistance for a vehicle class as determined in paragraph (h) of this section.
G_{i-1} = the percent grade interpolated at distance, D_{i-1} from the duty cycle in Appendix IV corresponding to measurement (i-1).

$$D_{\text{i-1}} = \sum_{i=1}^{N} \left(v_{\text{ref,i-1}} \cdot \Delta t_{\text{i-1}} \right) \qquad \text{Eq. 1037.550-4}$$

ρ = air density at reference conditions. Use ρ = 1.17 kg/m^3.
C_DA = drag area for a vehicle class as determined in paragraph (h) of this section.
F_{brake} = instantaneous braking force applied by the driver model.

$$F_{\text{grade,i-1}} = M \cdot g \cdot \sin\left(\text{atan}\left(G_{\text{i-1}}\right)\right) \qquad \text{Eq. 1037.550-5}$$

Δt = the time interval between measurements. For example, at 100 Hz, Δt = 0.0100 seconds.
$M_{rotating}$ = inertial mass of rotating components as determined in paragraph (h) of this section.

Example: Example is for Class 2b to 7 vocational vehicles with 6 speed automatic transmission at B speed (Test 4 in Table 1 of § 1037.550).

k_a = 4.0
$k_{topgear}$ = 0.6716
f_{nrefB} = 1870 rpm = 31.16 r/s
v_{65} = 65 mph = 29.05 m/s
T_{1000-1} = 500.0 N·m
C_{rr} = 6.9 kg/ton = 6.9·10 minus;3 kg/kg
M = 11408 kg
C_DA = 5.4 m^2
G_{1000-1} = 1.0% = 0.018

$$D_{1000\text{-}1} = \sum_{i=1}^{1000} \left(19.99 \cdot 0.01 + 20.0 \cdot 0.01 + \ldots + v_{\text{ref},1000-1} \cdot \Delta t_{1000-1} \right) = 1367\,\text{m}$$

$F_{brake_{10001}}$ = 0 N
$V_{ref10001}$ = 20.0 m/s
$F_{grade_{10001}}$ = 11408·9.81·sin (atan (0.018)) = 2014. N
ρ Δt = 0.0100 s
$M_{rotating}$ = 454 kg

$$r_{\mathrm{B}} = \frac{4.0 \cdot 0.6716 \cdot 29.05}{2 \cdot \pi \cdot 31.16} = 0.399\,\mathrm{m}$$

$$v_{\mathrm{ref}_{1000}} = \left(\begin{array}{l} \frac{4.0 \cdot 500.0}{0.399} \cdot (0.955) - \\ \left(11408 \cdot 9.81 \cdot 6.9 \cdot \cos\left(\operatorname{atan}(0.018)\right) + \frac{1.17 \cdot 5.4}{2} \cdot 20.0^2\right) - 0 - 2014.1 \end{array} \right) \cdot \frac{0.0100}{11408 + 454} + 20.0$$

$v_{\mathrm{ref1000}} = 20.00128$ m/s

$$f_{\mathrm{nref1000,dyno}} = \frac{20.00128 \cdot 4.28}{2 \cdot 3.14 \cdot 0.462} = 31.9515 \text{ r/s} = 1917.09 \text{ rpm}$$

(2) For testing with the dynamometer connected at the wheel hubs, calculate $f_{\mathrm{nref,dyno}}$ using the following equation:

$$f_{\mathrm{nrefi,dyno}} = \frac{v_{\mathrm{refi}}}{2 \cdot \pi \cdot r} \qquad \text{Eq. 1037.550-6}$$

(g) Design a driver model to mimic a human driver modulating the throttle and brake pedals to follow the test cycle as closely as possible. The driver model must meet the speed requirements for operation over the cruise cycles as described in § 1037.510 and for operation over the transient cycle as described in 40 CFR 1066.425(b). Design the driver model to meet the following specifications:

(1) Send a brake signal when throttle position is zero and vehicle speed is greater than the reference vehicle speed from the test cycle. Include a delay before changing the brake signal to prevent dithering, consistent with good engineering judgment.

(2) Allow braking only if throttle position is zero.

(3) Compensate for the distance driven over the duty cycle over the course of the test. Use the following equation to perform the compensation in real time to determine your time in the cycle:

$$t_{\mathrm{cycle}_i} = \sum_{i=1}^{N} \left(\left(\frac{v_{\mathrm{vehicle,i-1}}}{v_{\mathrm{cycle,i-1}}} \right) \cdot \Delta t_{\mathrm{i-1}} \right) \qquad \text{Eq. 1037.550-7}$$

Where:

v_{vehicle} = measured vehicle speed.

v_{cycle} = reference speed from the test cycle. If $v_{\mathrm{cycle,i-1}} < 1.0$ m/s, set $v_{\mathrm{cycle,i-1}} = v_{\mathrm{vehicle,i-1}}$.

(h) Set up the driver model and the vehicle model in the test cell to test the powertrain, as follows:

(1) For Class 2b through Class 7 vocational vehicles, test the powertrain over eight different test runs. For all test runs, set M_{rotating} to 454 kg, $C_{\mathrm{D}}A$ to 5.4, k_{a} to 4.0, and Eff_{axle} to 0.955. Set the tire radius, *r,* for each test run based on the vehicle configuration corresponding to the designated engine speed (A, B, C, or f_{ntest}, all from 40 CFR part 1065) at 65 mph. These engine speeds apply equally for spark-ignition engines. Use the following settings specific to each test run:

TABLE 1 OF § 1037.550—VEHICLE SETTINGS FOR POWERTRAIN TESTING OF CLASS 2b THROUGH CLASS 7 VOCATIONAL VEHICLES

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8
M (kg)	7,257	11,408	7,257	11,408	7,257	11,408	7,257	11,408.
C_{rr} (kg/metric ton)	6.7	6.9	6.7	6.9	6.7	6.9	6.7	6.9.
r at engine speed	A	A	B	B	C	C	Maximum test speed	Maximum test speed.

(2) For tractors and Class 8 vocational vehicles, test the powertrain over nine different test runs. For all test runs, set C_{rr} to 6.9, k_{a} to 4.0, and Eff_{axle} to 0.955. Set the tire radius, *r,* for each test run based on the vehicle configuration corresponding to the designated engine speed (the minimum NTE exclusion speed as determined in 40 CFR 86.1370(b)(1), B, or f_{ntest} from 40 CFR part 1065) at 65 mph. Use the settings specific to each test run from Table 2 of this section for general purpose vehicles, and from Table 3 of this section for heavy-haul tractors. Tables 2 and 3 follow:

TABLE 2 OF § 1037.550—VEHICLE SETTINGS FOR POWERTRAIN TESTING OF TRACTORS AND CLASS 8 VOCATIONAL VEHICLES—GENERAL PURPOSE VEHICLES

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9
M (kg)	31,978	22,679	19,051	31,978	22,679	19,051	31,978	22,679	19,051.
C_DA	5.4	4.7	4.0	5.4	4.7	4.0	5.4	4.7	4.0.
$M_{rotating}$ (kg)	1,134	907	680	1,134	907	680	1,134	907	680.
r at engine speed.	Minimum NTE exclusion speed.	Minimum NTE exclusion speed.	Minimum NTE exclusion speed.	B	B	B	Maximum test speed.	Maximum test speed.	Maximum test speed.

TABLE 3 OF § 1037.550—VEHICLE SETTINGS FOR POWERTRAIN TESTING OF HEAVY-HAUL TRACTORS

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9
M (kg)	40,895	31,978	22,679	40,895	31,978	22,679	40,895	31,978	22,679.
C_DA	6.1	5.4	4.7	6.1	5.4	4.7	6.1	5.4	4.7.
$M_{rotating}$ (kg)	1,134	907	680	1,134	907	680	1,134	907	680.
r at engine speed	Minimum NTE exclusion speed.	Minimum NTE exclusion speed.	Minimum NTE exclusion speed.	B	B	B	Maximum test speed.	Maximum test speed.	Maximum test speed.

(i) Operate the powertrain over each of the duty cycles specified in § 1037.510(a)(2).

(j) Collect and measure emissions as described in 40 CFR part 1065. For hybrid powertrains, correct for the net energy change of the energy storage device as described in 40 CFR 1066.501.

(k) For each test point, validate the measured output speed with the corresponding reference values. You may delete points when the vehicle is stopped. Apply cycle-validation criteria for each separate transient or cruise cycle based on the following parameters:

TABLE 4 OF § 1037.550—STATISTICAL CRITERIA FOR VALIDATING DUTY CYCLES

Parameter [a]	Speed control
Slope, a_1	$0.990 \le a_1 \le 1.010$.
Absolute value of intercept, $\lvert a_0 \rvert$.	≤2.0% of maximum test speed.
Standard error of estimate, *SEE*.	≤2.0% of maximum test speed.
Coefficient of determination, r^2.	≥ 0.990.

[a] Determine values for specified parameters as described in 40 CFR 1065.514(e) by comparing measured and reference values for $f_{nref,dyno}$.

(l) [Reserved]

(m) Calculate mass of fuel consumed for all duty cycles except idle as follows:

(1) For measurements involving measured fuel mass flow rate, calculate the mass of fuel for each duty cycle, $m_{fuel[cycle]}$, as follows:

$$m_{fuel} = \sum_{i=1}^{N} \dot{m}_{fueli} \cdot \Delta t \qquad \text{Eq. 1037.550-8}$$

Where:

N = total number of measurements over the duty cycle. For batch fuel mass measurements, set N = 1.

i = an indexing variable that represents one recorded value.

$\dot{m}_{fuel_i}$ = the fuel mass flow rate, for each point, i, starting from i = 1.

$\Delta t = 1/f_{record}$

f_{record} = the data recording frequency.

Example:

N = 6680

$\dot{m}_{fuel_1}$ = 1.856 g/s

$\dot{m}_{fuel_2}$ = 1.962 g/s

f_{record} = 10 Hz

Δt = 1/10 = 0.1 s

$m_{fueltransient} = (1.856 + 1.962 + \ldots + \dot{m}_{fuel6680}) \cdot 0.1$

$m_{fueltransient}$ = 111.95 g

(2) For tests using emission measurements (CO_2, CO, and THC) rather than measured fuel mass flow rate, calculate the mass of fuel for each duty cycle, $m_{fuel[cycle]}$, as follows:

(i) For calculations that use continuous measurement of emissions, calculate $m_{fuel[cycle]}$ using the following equation:

$$m_{fuel[cycle]} = \frac{M_C}{w_{Cmeas}} \cdot \left(\sum_{i=1}^{N_{[event]}} \left(\dot{n}_{exh_i} \cdot \frac{x_{Ccombdry_i}}{1 + x_{H2Oexhdry_i}} \cdot \Delta t_{[event]} \right) - \frac{1}{M_{CO2}} \sum_{j=1}^{N_{[event]}} \left(\dot{m}_{CO2urea_j} \cdot \Delta t_{[event]} \right) \right) \qquad \text{Eq. 1037.550-9}$$

Where:

$N_{[event]}$ = total number of measurements over the duty cycle.

i = an indexing variable that represents one recorded emission value.

w_{Cmeas} = carbon mass fraction of fuel as determined by 40 CFR 1065.655(d), except that you may not use the default properties in Table 1 of 40 CFR 1065.655 to determine α, β, and w_C for liquid fuels.

$\dot{n}_{exh}$ = exhaust molar flow rate from which you measured emissions.
$\chi_{Ccombdry}$ = amount of carbon from fuel in the exhaust per mole of dry exhaust.
$\chi_{H2Oexhdry}$ = amount of H_2O in exhaust per mole of exhaust.
j = an indexing variable that represents one recorded mass emission rate of CO_2 from urea value.
$\dot{m}_{CO2urea_j}$ = mass emission rate of CO_2 from the contribution of urea decomposition over the duty cycle as determined from 40 CFR 1036.535(a)(8). If your engine does not utilize urea SCR for emission control, or if you choose not to perform this correction, set this value equal to 0.

Example:
M_C = 12.0107 g/mol
w_{Cmeas} = 0.867
$N_{emission}$ = 6680
$N_{CO2urea}$ = 668
$\dot{n}_{exh1}$ = 2.876 mol/s
$\dot{n}_{exh2}$ = 2.224 mol/s
$\chi_{Ccombdry_1} = 2.61 \cdot 10^{-3}$ mol/mol
$\chi_{Ccombdry_2} = 1.91 \cdot 10^{-3}$ mol/mol
$\chi_{H2Oexh_1} = 3.53 \cdot 10^{-2}$ mol/mol
$\chi_{H2Oexh_2} = 3.13 \cdot 10^{-2}$ mol/mol
$f_{record\text{-}emission}$ = 10 Hz
$\Delta t_{emission}$ = 1/10 = 0.1 s
M_{CO2} = 44.0095 g/mol
$f_{record\text{-}CO2urea}$ = 1 Hz
$\Delta t_{CO2urea}$ = 1/1 = 1.0 s
$\dot{m}_{CO2urea_1}$ = 0.0726 g/s
$\dot{m}_{CO2urea_2}$ = 0.0751 g/s

$$m_{\text{fueltransient}} = \frac{12.0107}{0.867} \cdot \left(\left(\begin{array}{l} 2.876 \cdot \frac{2.61 \cdot 10^{-3}}{1+3.53 \cdot 10^{-2}} \cdot 0.1 + \\ 2.224 \cdot \frac{1.91 \cdot 10^{-3}}{1+3.13 \cdot 10^{-2}} \cdot 0.1 + \\ \ldots + \dot{n}_{\text{exh}_{6680}} \cdot \frac{x_{\text{Ccombdry}_{6680}}}{1+x_{\text{H2Oexhdry}_{6680}}} \cdot \Delta t_{6680} \end{array} \right) - \frac{1}{44.0095} \cdot \left(0.0726 \cdot 1.0 + 0.0751 \cdot 1.0 + \ldots + \dot{m}_{\text{CO2urea}_{668}} \cdot \Delta t_{668}\right) \right)$$

$m_{CO2transient}$ = 1619.6 g

(ii) If you measure batch emissions, calculate $m_{fuel[cycle]}$ using the following equation:

$$m_{\text{fuel[cycle]}} = \frac{M_{\text{C}}}{w_{\text{Cmeas}}} \cdot \left(\frac{\bar{x}_{\text{Ccombdry}}}{1+\bar{x}_{\text{H2Oexhdry}}} \cdot \sum_{i=1}^{N_{\text{[event]}}} \left(\dot{n}_{\text{exh}_i} \cdot \Delta t_{\text{[event]}} \right) - \frac{1}{M_{\text{CO2}}} \sum_{j=1}^{N_{\text{[event]}}} \left(\dot{m}_{\text{CO2urea}_j} \cdot \Delta t_{\text{[event]}} \right) \right) \quad \text{Eq. 1037.550-10}$$

(iii) If you measure continuous emissions and batch CO_2 from urea, calculate $m_{fuel[cycle]}$ using the following equation:

$$m_{\text{fuel[cycle]}} = \frac{M_{\text{C}}}{w_{\text{Cmeas}}} \cdot \left(\sum_{i=1}^{N_{\text{[event]}}} \left(\dot{n}_{\text{exh}_i} \cdot \frac{x_{\text{Ccombdry}_i}}{1+x_{\text{H2Oexhdry}_i}} \cdot \Delta t_{\text{[event]}} \right) - \frac{m_{\text{CO2urea}}}{M_{\text{CO2}}} \right) \quad \text{Eq. 1037.550-11}$$

(iv) If you measure batch emissions and batch CO_2 from urea, calculate $m_{fuel[cycle]}$ using the following equation:

$$m_{\text{fuel[cycle]}} = \frac{M_{\text{C}}}{w_{\text{Cmeas}}} \cdot \left(\frac{\bar{x}_{\text{Ccombdry}}}{1+\bar{x}_{\text{H2Oexhdry}}} \cdot \sum_{i=1}^{N_{\text{[event]}}} \left(\dot{n}_{\text{exh}_i} \cdot \Delta t_{\text{[event]}} \right) - \frac{m_{\text{CO2urea}}}{M_{\text{CO2}}} \right) \quad \text{Eq. 1037.550-12}$$

(n) Determine the mass of fuel consumed at idle as follows:

(1) Measure fuel consumption with a fuel flow meter and report the mean fuel mass flow rate for each duty cycle, $\bar{\dot{m}}_{fuelidle}$.

(2) For measurements that do not involve measured fuel mass flow rate, calculate the fuel mass flow rate for each duty cycle, $\bar{\dot{m}}_{fuelidle}$, for each set of vehicle settings, as follows:

$$\bar{\dot{m}}_{\text{fuelidle}} = \frac{M_{\text{C}}}{w_{\text{Cmeas}}} \cdot \left(\bar{\dot{n}}_{\text{exh}} \cdot \frac{\bar{x}_{\text{Ccombdry}}}{1+\bar{x}_{\text{H2Oexhdry}}} - \frac{\bar{\dot{m}}_{\text{CO2urea}}}{M_{\text{CO2}}} \right) \quad \text{Eq. 1037.550-13}$$

Where:

$\bar{\dot{n}}_{exh}$ = the mean raw exhaust molar flow rate from which you measured emissions.

$\dot{m}_{CO2urea}$ = mass emission rate of CO_2 from the contribution of urea decomposition over the duty cycle as determined from 40 CFR 1036.535(a)(8), for each point, *i*, starting from *i* = 1. If your engine does not utilize urea SCR for emission control, or if you choose not to perform this correction, set this value equal to 0.

M_C = molar mass of carbon.

w_{Cmeas} = carbon mass fraction of fuel as determined by 40 CFR 1065.655(d), except that you may not use the default properties in Table 1 of 40 CFR 1065.655 to determine α, β, and w_C for liquid fuels.

$\bar{\dot{n}}_{exh}$ = the mean raw exhaust molar flow rate from which you measured emissions according to 40 CFR 1065.655.

$\bar{\chi}_{Ccombdry}$ = the mean concentration of carbon from fuel in the exhaust per mole of dry exhaust.

$\bar{\chi}_{H2Oexhdry}$ = the mean concentration of H_2O in exhaust per mole of dry exhaust.

$\bar{\dot{m}}_{CO2urea}$ = the mean CO_2 mass emission rate from urea decomposition as described in paragraph (c)(9) of this section. If your engine does not utilize urea SCR for emission control, or if you choose not to perform this correction, set $\bar{\dot{m}}_{CO2urea}$ equal to 0.

M_{CO2} = molar mass of carbon dioxide.

Example:

$$M_C = 12.0107 \text{ g/mol}$$

$$w_{Cmeas} = 0.867$$

$$\bar{\dot{n}}_{exh} = 25.534 \text{ mol/s}$$

$$x_{Ccombdry} = 2.805 \cdot 10^{-3} \text{ mol/mol}$$

$$x_{H2Oexhdry} = 3.53 \cdot 10^{-2} \text{ mol/mol}$$

$$\bar{\dot{m}}_{CO2urea} = 0.0726 \text{ g/s}$$

$$M_{CO2} = 44.0095$$

$$\bar{\dot{m}}_{fuelidle} = \frac{12.0107}{0.867} \cdot \left(25.534 \cdot \frac{2.805 \cdot 10^{-3}}{1 + 3.53 \cdot 10^{-2}} - \frac{0.0726}{44.0095}\right)$$

$$\bar{\dot{m}}_{fuelidle} = 0.405 \text{ g/s} = 1458.6 \text{ g/hr}$$

(o) Use the results of powertrain testing to determine GEM inputs as described in this paragraph (o). Declare a fuel mass consumption rate at idle $\bar{\dot{m}}_{fuelidle}$, as described in paragraph (b) of this section. Include additional parameters for each of the eight or nine simulated vehicle configurations as follows:

(1) Your declared fuel mass consumption for both cruise cycles and for the transient cycle, $m_{fuel[cycle]}$, as described in paragraph (b) of this section.

(2) Powertrain output speed per unit of vehicle speed. If the test is done with the dynamometer connected at the wheel hubs set k_a to the axle ratio of the rear axle that was used in the test. If the vehicle does not have a drive axle, such as hybrid vehicles with direct electric drive, let k_a = 1.

$$\frac{f_{npowertrain}}{v_{powertrain}} = \frac{k_a}{2 \cdot \pi \cdot r_{[speed]}}$$

(3) Positive work, $W_{[cycle]powertrain}$, over the duty cycle at the transmission output or wheel hubs from the powertrain test.

(4) The following table illustrates the GEM data inputs corresponding to the different vehicle configurations:

Table 5 of § 1037.550 – Example test result output matrix for Class 8 vehicles.

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9
$m_{\text{fuel[cycle]powertrain}}$									
$\frac{f_{\text{npowertrain}}}{v_{\text{powertrain}}}$									
$W_{\text{[cycle]powertrain}}$									

(p) Correct each fuel-consumption result from paragraph (o) of this section for the test fuel's mass-specific net energy content as described in 40 CFR 1036.530.

(q) For each test run, record the engine speed and torque as defined in 40 CFR 1065.915(d)(5) with a minimum sampling frequency of 1 Hz. These engine speed and torque values represent a duty cycle that can be used for separate testing with an engine mounted on an engine dynamometer, such as for a selective enforcement audit as described in § 1037.301.

§ 1037.551 Engine-based simulation of powertrain testing.

Section 1037.550 describes how to measure fuel consumption over specific duty cycles with an engine coupled to a transmission; § 1037.550(q) describes how to create equivalent duty cycles for repeating those same measurements with just the engine. This § 1037.551 describes how to perform this engine testing to simulate the powertrain test. These engine-based measurements may be used for confirmatory testing as described in § 1037.235, or for selective enforcement audits as described in § 1037.301, as long as the test engine's operation represents the engine operation observed in the powertrain test.

(a) Use the procedures of 40 CFR part 1065 to set up the engine, measure emissions, and record data. Measure individual parameters and emission constituents as described in this section. Measure NO_X emissions during each of the specified sampling periods consistent with the data requirements 40 CFR part 86, subpart T. You may use emission-measurement systems meeting the specifications of 40 CFR part 1065, subpart J, to measure NO_X emissions. For hybrid powertrains, correct for the net energy change of the energy storage device as described in 40 CFR 1066.501.

(b) Operate the engine over the applicable engine duty cycles corresponding to the vehicle cycles specified in § 1037.510(a)(2) for powertrain testing over the applicable vehicle simulations described in § 1037.550(h). Warm up the engine to prepare for the transient test or one of the cruise cycles by operating it one time over one of the simulations of the corresponding duty cycle. Warm up the engine to prepare for the idle test by operating it over a simulation of the 65-mph cruise cycle for 600 seconds. Within 60 seconds after concluding the warm up cycle, start emission sampling while the engine operates over the duty cycle. You may perform any number of test runs directly in succession once the engine is warmed up. Perform cycle validation as described in 40 CFR 1065.514 for engine speed, torque, and power.

(c) Calculate the mass of fuel consumed as described in § 1037.550(m) and (n). Correct each measured value for the test fuel's mass-specific net energy content as described in 40 CFR 1036.530. Use these corrected values to determine whether the engine's emission levels conform to the declared fuel-consumption rates from the powertrain test.

§ 1037.555 Special procedures for testing Phase 1 post-transmission hybrid systems.

This section describes the procedure for simulating a chassis test with a pre-transmission or post-transmission hybrid system for A to B testing of Phase 1 vehicles. These procedures may also be used to perform A to B testing with non-hybrid systems. See § 1037.550 for Phase 2 hybrid systems.

(a) Set up the engine according to 40 CFR 1065.110 to account for work inputs and outputs and accessory work.

(b) Collect CO_2 emissions while operating the system over the test cycles specified in § 1037.510(a)(1).

(c) Collect and measure emissions as described in 40 CFR part 1066. Calculate emission rates in grams per ton-mile without rounding. Determine values for *A, B, C,* and *M* for the vehicle being simulated as specified in 40 CFR part 1066. If you will apply an improvement factor or test results to multiple vehicle configurations, use values of *A, B, C, M,* k_a, and *r* that represent the vehicle configuration with the smallest potential reduction in greenhouse gas emissions as a result of the hybrid capability.

(d) Calculate the transmission output shaft's angular speed target for the driver model, $f_{\text{nref,driver}}$, from the linear speed associated with the vehicle cycle using the following equation:

$$f_{\text{nref}_{\text{i,driver}}} = \frac{v_{\text{cycle}_\text{i}} \cdot k_\text{a}}{2 \cdot \pi \cdot r} \qquad \text{Eq. 1037.555-1}$$

Where:

v_{cyclei} = vehicle speed of the test cycle for each point, *i,* starting from *i*=1.

k_a = drive axle ratio, as declared by the manufacturer.

r = radius of the loaded tires, as declared by the manufacturer.

(e) Use speed control with a loop rate of at least 100 Hz to program the dynamometer to follow the test cycle, as follows:

(1) Calculate the transmission output shaft's angular speed target for the dynamometer, $f_{\text{nref,dyno}}$, from the measured linear speed at the dynamometer rolls using the following equation:

$$f_{\mathrm{nref}_{\mathrm{i,dyno}}} = \frac{v_{\mathrm{ref}_{\mathrm{i}}} \cdot k_{\mathrm{a}}}{2 \cdot \pi \cdot r} \qquad \text{Eq. 1037.555-2}$$

Where:

$$v_{\mathrm{ref}_{\mathrm{i}}} = \left(\frac{k_{\mathrm{a}} \cdot T_{\mathrm{i-1}}}{r} - \left(A + B \cdot v_{\mathrm{ref}_{\mathrm{i-1}}} + C \cdot v_{\mathrm{ref}_{\mathrm{i-1}}}^2 \right) - F_{\mathrm{brake}_{\mathrm{i-1}}} \right) \cdot \frac{t_{\mathrm{i}} - t_{\mathrm{i-1}}}{M} + v_{\mathrm{ref}_{\mathrm{i-1}}} \qquad \text{Eq. 1037.555-3}$$

T = instantaneous measured torque at the transmission output shaft.
F_{brake} = instantaneous brake force applied by the driver model to add force to slow down the vehicle.
t = elapsed time in the driving schedule as measured by the dynamometer, in seconds.

(2) For each test, validate the measured transmission output shaft's speed with the corresponding reference values according to 40 CFR 1065.514(e). You may delete points when the vehicle is stopped. Perform the validation based on speed values at the transmission output shaft. For steady-state tests (55 mph and 65 mph cruise), apply cycle-validation criteria by treating the sampling periods from the two tests as a continuous sampling period. Perform this validation based on the following parameters:

TABLE 1 OF § 1037.555—STATISTICAL CRITERIA FOR VALIDATING DUTY CYCLES

Parameter	Speed control
Slope, a_1	$0.950 \leq a_1 \leq 1.030$.
Absolute value of intercept, $\lvert a_0 \rvert$.	≤2.0% of maximum test speed.
Standard error of estimate, *SEE*.	≤5% of maximum test speed.
Coefficient of determination, r^2.	≥0.970.

(f) Send a brake signal when throttle position is equal to zero and vehicle speed is greater than the reference vehicle speed from the test cycle. Set a delay before changing the brake state to prevent the brake signal from dithering, consistent with good engineering judgment.

(g) The driver model should be designed to follow the cycle as closely as possible and must meet the requirements of § 1037.510 for steady-state testing and 40 CFR 1066.430(e) for transient testing. The driver model should be designed so that the brake and throttle are not applied at the same time.

(h) Correct for the net energy change of the energy storage device as described in 40 CFR 1066.501.

(i) Follow the provisions of § 1037.510 to weight the cycle results and § 1037.615 to calculate improvement factors and benefits for advanced technologies for Phase 1 vehicles.

§ 1037.560 Rear-axle efficiency test.

This section describes a procedure for mapping rear-axle efficiency.

(a) Prepare an axle assembly for testing as follows:

(1) Select a newly manufactured axle assembly housing.

(2) If you have a family of axle assemblies with different axle ratios, you may test multiple configurations using a common axle housing.

(3) Install the axle with an input shaft angle perpendicular to the axle.

(i) If the axle assembly has a locking differential, lock the main differential and test it with one electric motor on the input shaft and a second electric motor on the output side of the output shaft that has the speed-reduction gear attached to it.

(ii) If an axle assembly has an open differential, use an alternate method to lock the differential for testing.

(iii) For drive-through tandem-axle setups, lock the longitudinal and inter-wheel differentials.

(4) Add gear lubricant according to the axle manufacturer's instructions. Use gear lubricant meeting the specification for BASF Emgard FE 2986 as described in ''Emgard® FE 75W–90 Fuel Efficient Synthetic Gear Lubricant'' (incorporated by reference in § 1037.810). Use this gear lubricant for all axle operation under this section.

(5) Install equipment for measuring the bulk temperature of the gear lubricant in the oil sump or a similar location.

(6) Break in the axle assembly by warming it up until the gear lubricant is as least 85 °C, and then operating it for 77 minutes at an angular wheel speed of 246 rpm at each of three differential torque settings, 25%, 50%, and 75%, in sequence, where differential torque is expressed as a percentage of the axle manufacturer's torque rating. Maintain gear lubricant temperature at 90±5 °C throughout the warm-up period.

(7) Drain and refill the gear lubricant following the break-in procedure.

(b) Measure input and output speeds and torques as described in 40 CFR 1065.210(b). Calibrate and verify measurement instruments according to 40 CFR part 1065, subpart C. Record all data, including bulk oil temperature, at a minimum of 256 Hz.

(c) The test matrix consists of torque and wheel speed values meeting the following specifications:

(1) Input torque values range from 1,000 to 4,000 N·m in 1,000 N·m increments; also include a test point with an output torque of 0 N·m.

(2) Determine maximum wheel speed corresponding to a vehicle speed of 65 mph based on the smallest tire that will be used with the axle. Use wheel speeds for testing that include maximum wheel speed, 50 rpm, and intermediate speeds in 100-rpm increments up to maximum wheel speed (150, 250, etc.). You may omit the last 100-rpm increment if it is within 10 rpm of the maximum wheel speed, and instead test at maximum wheel speed for the last test point.

(3) The average of measured values corresponding to each separate torque-measurement point must be within ±1 N·m of the setpoint for input torque, and within ±1 rpm of the setpoint for output speed.

(d) Determine rear-axle efficiency using the following procedure:

(1) Maintain ambient temperature between (20 and 30) °C throughout testing. Measure ambient temperature within 1.0 m of the axle assembly.

(2) Maintain gear lubricant temperature at 82±1 °C. You may use external heating and cooling as needed.

(3) Warm up the axle by operating it at maximum wheel speed and at zero output torque until the gear lubricant is within the specified temperature range.

(4) Continue operating at maximum wheel speed and zero output torque for at least 300 seconds, then measure the input torque, output torque, and wheel speed for at least 300 seconds, recording the average values for all three parameters. Repeat this stabilization and measurement sequence sequentially for higher torque setpoints from the test

matrix while holding wheel speed constant. Repeat the stabilization and measurement sequence at the same wheel speed from highest to lowest torque. This results in two measurements at each torque setting. Perform the stabilization and measurement sequence again in a sequence from low to high torque values, then from high to low torque values, all at the same wheel speed, resulting in four measurements at each torque setting. Calculate an arithmetic average value for input torque, output torque, and wheel speed at each torque setting.

(5) Decrease wheel speed to the next lower speed setting and repeat the torque sweep described in paragraph (d)(4) of this section to determine input torque, output torque, and wheel speed results for all the torque settings at the new wheel speed. Repeat this process in order of decreasing wheel speed until the mapping is complete for all points in the test matrix. If the test is aborted before completing the map, invalidate all the measurements made at that wheel speed. Once the problem has been resolved, warm up the axle as described in paragraph (d)(3) of this section and continue with measurements from the wheel speed where you stopped testing.

(e) Calculate the torque loss, T_{loss}, at each point from the test matrix using the following equation:

$$T_{loss} = T_{in} \cdot k_a - T_{out} \qquad \text{Eq. 1037.560-1}$$

Where:

T_{in} = input torque.

k_a = drive axle ratio, expressed to at least the nearest 0.001.

T_{out} = the output torque.

Example:

T_{in} = 1000.0 N·m

k_a = 3.731

T_{out} = 3695.1 N·m

T_{loss} = 1000.0 · 3.731 − 3695.1 = 35.9 N·m

Subpart G—Special Compliance Provisions

§ 1037.601 General compliance provisions.

(a) Engine and vehicle manufacturers, as well as owners and operators of vehicles subject to the requirements of this part, and all other persons, must observe the provisions of this part, the provisions of 40 CFR part 1068, and the provisions of the Clean Air Act. The provisions of 40 CFR part 1068 apply for heavy-duty vehicles as specified in that part, subject to the following provisions:

(1) Except as specifically allowed by this part or 40 CFR part 1068, it is a violation of § 1068.101(a)(1) to introduce into U.S. commerce a tractor or vocational vehicle containing an engine not certified to the requirements of this part and 40 CFR part 86 corresponding to the calendar year for date of manufacture of the tractor or vocational vehicle. Similarly, it is a violation to introduce into U.S. commerce a Phase 1 tractor containing an engine not certified for use in tractors; or to introduce into U.S. commerce a vocational vehicle containing a light heavy-duty or medium heavy-duty engine not certified for use in vocational vehicles. These prohibitions apply especially to the vehicle manufacturer. Note that this paragraph (a)(1) allows the use of Class 8 tractor engines in vocational vehicles.

(2) The provisions of 40 CFR 1068.105(a) apply for vehicle manufacturers installing engines certified under 40 CFR part 1036 as further limited by this paragraph (a)(2). If new engine emission standards apply in a given model year, you may install engines built before the date of the new or changed standards under the provisions of 40 CFR 1068.105(a) through March 31 of that year without our approval; you may not install such engines after March 31 of that year unless we approve it in advance. Installing such engines after March 31 without our prior approval is considered to be prohibited stockpiling of engines. In a written request for our approval, you must describe how your circumstances led you and your engine supplier to have normal inventories of engines that were not used up in the specified time frame. We will approve your request for up to three additional months to install up to 50 engines under this paragraph (a)(2) if we determine that the excess inventory is a result of unforeseeable circumstances and should not be considered circumvention of emission standards.

(3) The provisions of 40 CFR 1068.235 that allow for modifying certified vehicles and engines for competition do not apply for heavy-duty vehicles or heavy-duty engines. Certified motor vehicles and motor vehicle engines and their emission control devices must remain in their certified configuration even if they are used solely for competition or if they become nonroad vehicles or engines; anyone modifying a certified motor vehicle or motor vehicle engine for any reason is subject to the tampering and defeat device prohibitions of 40 CFR 1068.101(b) and 42 U.S.C. 7522(a)(3). Note that a new vehicle that will be used solely for competition may be excluded from the requirements of this part based on a determination that the vehicle is not a motor vehicle under 40 CFR 85.1703.

(4) The tampering prohibition in 40 CFR 1068.101(b)(1) applies for alternative fuel conversions as specified in 40 CFR part 85, subpart F.

(5) The warranty-related prohibitions in section 203(a)(4) of the Act (42 U.S.C. 7522(a)(4)) apply to manufacturers of new heavy-duty highway vehicles in addition to the prohibitions described in 40 CFR 1068.101(b)(6). We may assess a civil penalty up to $37,500 for each engine or vehicle in violation.

(6) The hardship exemption provisions of 40 CFR 1068.245, 1068.250, and 1068.255 do not apply for heavy-duty vehicles.

(7) A vehicle manufacturer that completes assembly of a vehicle at two or more facilities may ask to use as the date of manufacture for that vehicle the date on which manufacturing is completed at the place of main assembly, consistent with provisions of 49 CFR 567.4. Note that such staged assembly is subject to the corresponding provisions of 40 CFR 1068.260. Include your request in your application for certification, along with a summary of your staged-assembly process. You may ask to apply this allowance to some or all of the vehicles in your vehicle family. Our approval is effective when we grant your certificate. We will not approve your request if we determine that you intend to use this allowance to circumvent the intent of this part.

(8) The provisions for selective enforcement audits apply as described in 40 CFR part 1068, subpart E, and § 1037.301.

(b) Vehicles exempted from the applicable standards of 40 CFR part 86 are exempt from the standards of this part without request. Similarly, vehicles are exempt without request if the installed engine is exempted from the applicable standards in 40 CFR part 86.

(c) The prohibitions of 40 CFR 1068.101 apply for vehicles subject to the requirements of this part. The actions prohibited under this provision include the introduction into U.S.

commerce of a complete or incomplete vehicle subject to the standards of this part where the vehicle is not covered by a valid certificate of conformity or exemption.

(d) The emergency vehicle field modification provisions of 40 CFR 85.1716 apply with respect to the standards of this part.

(e) Under § 1037.801, certain vehicles are considered to be new vehicles when they are imported into the United States, even if they have previously been used outside the country. Independent Commercial Importers may use the provisions of 40 CFR part 85, subpart P, and 40 CFR 85.1706(b) to receive a certificate of conformity for engines and vehicles meeting all the requirements of 40 CFR part 1036 and this part 1037.

(f) Standards apply to multi-fuel vehicles as described for engines in 40 CFR 1036.601(d).

§ 1037.605 Installing engines certified to alternate standards for specialty vehicles.

(a) *General provisions.* This section allows vehicle manufacturers to introduce into U.S. commerce certain new motor vehicles if the engines are certified to alternate emission standards that are equivalent to standards that apply for nonroad engines under 40 CFR part 1039 or 1048. See 40 CFR 86.007–11(g) and 40 CFR 86.008–10(g). The provisions of this section apply for the following types of vehicles:

(1) Vehicles with a hybrid powertrain in which the engine provides energy for the Rechargeable Energy Storage System.

(2) Amphibious vehicles.

(3) Vehicles with maximum speed at or below 45 miles per hour. If your vehicle is speed-limited to meet this specification by reducing maximum speed below what is otherwise possible, this speed limitation must be programmed into the engine or vehicle's electronic control module in a way that is tamper-proof. If your vehicles are not inherently limited to a maximum speed at or below 45 miles per hour, they may qualify under this paragraph (a)(3) only if we approve your design to limit maximum speed as being tamper-proof in advance.

(b) *Notification and reporting requirements.* Send the Designated Compliance Officer written notification describing your plans before using the provisions of this section. In addition, by February 28 of each calendar year (or less often if we tell you), send the Designated Compliance Officer a report with all the following information:

(1) Identify your full corporate name, address, and telephone number.

(2) List the vehicle and engine models for which you used this exemption in the previous year and identify the total number of vehicles.

(c) *Production limits.* You may produce up to 1,000 hybrid vehicles, up to 200 amphibious vehicles, and up to 200 speed-limited vehicles under this section in a given model year. This includes vehicles produced by affiliated companies. If you exceed this limit, the exemption is void for the number of vehicles that exceed the limit for the model year. For the purpose of this paragraph (c), we will include all vehicles labeled or otherwise identified as exempt under this section.

(d) *Vehicle standards.* Hybrid vehicles using the provisions of this section remain subject to all other requirements of this part 1037. For example, you must use GEM in conjunction with powertrain testing to demonstrate compliance with emission standards under subpart B of this part. Vehicles qualifying under paragraph (a)(2) or (a)(3) of this section are exempt from the requirements of this part, except as specified in this section; these vehicles must include a label as specified in § 1037.135(a) with the information from § 1037.135(c)(1) and (2) and the following statement: ''THIS [amphibious vehicle or speed-limited vehicle] IS EXEMPT FROM GREENHOUSE GAS STANDARDS UNDER 40 CFR 1037.605.''

§ 1037.610 Vehicles with off-cycle technologies.

(a) You may ask us to apply the provisions of this section for CO_2 emission reductions resulting from vehicle technologies that were not in common use with heavy-duty vehicles before model year 2010 that are not reflected in GEM. These may be described as off-cycle or innovative technologies. These provisions may be applied for CO_2 emission reductions reflected using the specified test procedures, provided they are not reflected in GEM. We will apply these provisions only for technologies that will result in measurable, demonstrable, and verifiable real-world CO_2 emission reductions. This section does not apply for trailers.

(b) The provisions of this section may be applied as either an improvement factor or as a separate credit within the vehicle family, consistent with good engineering judgment. Note that the term ''credit'' in this section describes an additive adjustment to emission rates and is not equivalent to an emission credit in the ABT program of subpart H of this part. We recommend that you base your credit/adjustment on A to B testing of pairs of vehicles differing only with respect to the technology in question.

(1) Calculate improvement factors as the ratio of in-use emissions with the technology divided by the in-use emissions without the technology. Use the improvement-factor approach where good engineering judgment indicates that the actual benefit will be proportional to emissions measured over the test procedures specified in this part.

(2) Calculate separate credits (g/ton-mile) based on the difference between the in-use emission rate with the technology and the in-use emission rate without the technology. Subtract this value from your GEM result and use this adjusted value to determine your FEL. Use the separate-credit approach where good engineering judgment indicates that the actual benefit will be not be proportional to emissions measured over the test procedures specified in this part.

(3) We may require you to discount or otherwise adjust your improvement factor or credit to account for uncertainty or other relevant factors.

(c) You may perform A to B testing by measuring emissions from the vehicles during chassis testing or from in-use on-road testing. We recommend that you perform on-road testing according to SAE J1321, Fuel Consumption Test Procedure—Type II, revised February 2012, or SAE J1526, Joint TMC/SAE Fuel Consumption In-Service Test Procedure Type III, Issued June 1987 (see § 1037.810 for information on availability of SAE standards), subject to the following provisions:

(1) The minimum route distance is 100 miles.

(2) The route selected must be representative in terms of grade. We will take into account published and relevant research in determining whether the grade is representative.

(3) Control vehicle speed over the route to be representative of the drive-cycle weighting adopted for each regulatory subcategory, as specified in § 1037.510(c), or apply a correction to account for the appropriate weighting. For example, if the route selected for an evaluation of a combination tractor with a sleeper cab contains only interstate driving at 65 mph, the improvement factor would apply only to 86 percent of the weighted result.

(4) The ambient air temperature must be between (5 and 35) °C, unless the technology requires other temperatures for demonstration.

(5) We may allow you to use a Portable Emissions Measurement System (PEMS) device for measuring

CO_2 emissions during the on-road testing.

(d) Send your request to the Designated Compliance Officer. We recommend that you do not begin collecting test data (for submission to EPA) before contacting us. For technologies for which the engine manufacturer could also claim credits (such as transmissions in certain circumstances), we may require you to include a letter from the engine manufacturer stating that it will not seek credits for the same technology. Your request must contain the following items:

(1) A detailed description of the off-cycle technology and how it functions to reduce CO_2 emissions under conditions not represented on the duty cycles required for certification.

(2) A list of the vehicle configurations that will be equipped with the technology.

(3) A detailed description and justification of the selected test vehicles.

(4) All testing and simulation data required under this section, plus any other data you have considered in your analysis. You may ask for our preliminary approval of your test plan under § 1037.210.

(5) A complete description of the methodology used to estimate the off-cycle benefit of the technology and all supporting data, including vehicle testing and in-use activity data. Also include a statement regarding your recommendation for applying the provisions of this section for the given technology as an improvement factor or a credit.

(6) An estimate of the off-cycle benefit by vehicle model, and the fleetwide benefit based on projected sales of vehicle models equipped with the technology.

(7) A demonstration of the in-use durability of the off-cycle technology, based on any available engineering analysis or durability testing data (either by testing components or whole vehicles).

(8) A recommended method for auditing production vehicles consistent with the intent of 40 CFR part 1068, subpart E. We may approve your recommended method or specify a different method.

(e) We may seek public comment on your request, consistent with the provisions of 40 CFR 86.1866. However, we will generally not seek public comment on credits or adjustments based on A to B chassis testing performed according to the duty-cycle testing requirements of this part or in-use testing performed according to paragraph (c) of this section.

(f) We may approve an improvement factor or credit for any vehicle family that is properly represented by your testing. You may similarly continue to use an approved improvement factor or credit for any appropriate vehicle families in future model years through 2020. Starting in model year 2021, you must request our approval before applying an improvement factor or credit under this section for any kind of technology, even if we approved an improvement factor or credit for similar vehicle models before model year 2021.

§ 1037.615 Hybrid vehicles and other advanced technologies.

(a) This section applies for Phase 1 hybrid vehicles with regenerative braking, vehicles equipped with Rankine-cycle engines, electric vehicles, and fuel cell vehicles. You may not generate credits for engine features for which the engines generate credits under 40 CFR part 1036. Note that Phase 2 and later hybrid vehicles may be powertrain tested under § 1037.550 to demonstrate the performance of hybrid powertrains.

(b) Generate advanced technology emission credits for hybrid vehicles that include regenerative braking (or the equivalent) and energy storage systems, fuel cell vehicles, and vehicles equipped with Rankine-cycle engines as follows:

(1) Measure the effectiveness of the advanced system by chassis testing a vehicle equipped with the advanced system and an equivalent conventional vehicle, or by testing the hybrid systems and the equivalent non-hybrid systems as described in § 1037.555. Test the vehicles as specified in subpart F of this part. For purposes of this paragraph (b), a conventional vehicle is considered to be equivalent if it has the same footprint (as defined in 40 CFR 86.1803), vehicle service class, aerodynamic drag, and other relevant factors not directly related to the hybrid powertrain. If you use § 1037.540 to quantify the benefits of a hybrid system for PTO operation, the conventional vehicle must have the same number of PTO circuits and have equivalent PTO power. If you do not produce an equivalent vehicle, you may create and test a prototype equivalent vehicle. The conventional vehicle is considered Vehicle A and the advanced vehicle is considered Vehicle B. We may specify an alternate cycle if your vehicle includes a power take-off.

(2) Calculate an improvement factor and g/ton-mile benefit using the following equations and parameters:

(i) Improvement Factor = [(Emission Rate A) − (Emission Rate B)]/(Emission Rate A).

(ii) g/ton-mile benefit = Improvement Factor × (GEM Result B).

(iii) Emission Rates A and B are the g/ton-mile CO_2 emission rates of the conventional and advanced vehicles, respectively, as measured under the test procedures specified in this section. GEM Result B is the g/ton-mile CO_2 emission rate resulting from emission modeling of the advanced vehicle as specified in § 1037.520.

(3) If you apply an improvement factor to multiple vehicle configurations using the same advanced technology, use the vehicle configuration with the smallest potential reduction in greenhouse gas emissions resulting from the hybrid capability.

(4) Use the equations of § 1037.705 to convert the g/ton-mile benefit to emission credits (in Mg). Use the g/ton-mile benefit in place of the (Std-FEL) term.

(c) See § 1037.540 for special testing provisions related to vehicles equipped with hybrid power take-off units.

(d) You may use an engineering analysis to calculate an improvement factor for fuel cell vehicles based on measured emissions from the fuel cell vehicle.

(e) For electric vehicles, calculate CO_2 credits using an FEL of 0 g/ton-mile.

(f) As specified in subpart H of this part, credits generated under this section may be used under this part 1037 outside of the averaging set in which they were generated or used under 40 CFR part 1036.

(g) You may certify using both provisions of this section and the off-cycle technology provisions of § 1037.610, provided you do not double count emission benefits.

§ 1037.620 Responsibilities for multiple manufacturers.

This section describes certain circumstances in which multiple manufacturers share responsibilities for vehicle they produce together. This section does limit responsibilities that apply under the Act or these regulations for anyone meeting the definition of ''manufacturer'' in § 1037.801.

(a) The delegated assembly provisions of § 1037.621 apply for certifying manufacturers that rely on other manufacturers to finish assembly in a certified configuration. The provisions of § 1037.622 apply for manufacturers that ship vehicles subject to the requirements of this part to a certifying secondary vehicle manufacturer. The provisions of § 1037.622 also apply to the secondary manufacturer.

(b) Manufacturers of aerodynamic devices may perform the aerodynamic testing described in § 1037.525 to quantify C_DA values for trailers and submit that data to EPA verification under § 1037.211. Trailer manufacturers may use such verified data to establish modeling inputs for certifying their trailers. Both device manufacturers and trailer manufacturers are subject to the recall provisions described in 40 CFR part 1068, subpart F.

(c) Tire manufacturers must comply with the provisions of § 1037.650.

§ 1037.621 Delegated assembly.

(a) This section describes an exemption that allows certificate holders to sell or ship vehicles that are missing certain emission-related components if those components will be installed by a secondary vehicle manufacturer. (**Note:** See § 1037.622 for provisions related to manufacturers introducing into U.S. commerce partially complete vehicles for which a secondary vehicle manufacturer holds the certificate of conformity.) This exemption is temporary as described in 40 CFR 1068(f).

(b) The provisions of 40 CFR 1068.261 apply for vehicles subject to GHG standards under this part, with the following exceptions and clarifications:

(1) Understand references to ''engines'' to refer to vehicles.

(2) Understand references to ''aftertreatment components'' to refer to any emission-related components needed for complying with GHG standards under this part.

(3) Understand ''equipment manufacturers'' to be secondary vehicle manufacturers.

(4) The provisions of 40 CFR 1068.261(b), (c)(7), (d), and (e) do not apply. Accordingly, the provisions of 40 CFR 1068.261(c) apply regardless of pricing arrangements.

§ 1037.622 Shipment of incomplete vehicles to secondary vehicle manufacturers.

This section specifies how manufacturers may introduce partially complete vehicles into U.S. commerce. The provisions of this section do not apply for trailers, except in unusual circumstances. You may not use the provisions of this section to circumvent the intent of this part.

(a) The provisions of this section allow manufacturers to ship partially complete vehicles to secondary vehicle manufacturers or otherwise introduce them into U.S. commerce in the following circumstances:

(1) *Tractors.* Manufacturers may introduce partially complete tractors into U.S. commerce if they are covered by a certificate of conformity for tractors and will be in their certified tractor configuration before they reach the ultimate purchasers. For example, this would apply for sleepers initially shipped without the sleeper compartments attached. Note that delegated assembly provisions may apply (see § 1037.621).

(2) *Small businesses modifying certified tractors.* Small businesses that build custom sleeper cabs may modify complete or incomplete vehicles certified as tractors, as long as they do not increase the effective frontal area of the certified configuration.

(3) *Vocational vehicles.* Manufacturers may introduce partially complete vocational vehicles into U.S. commerce if they are covered by a certificate of conformity for vocational vehicles and will be in their certified vocational configuration before they reach the ultimate purchasers. Note that delegated assembly provisions may apply (see § 1037.621).

(4) *Uncertified vehicles that will be certified by secondary vehicle manufacturers.* Manufacturers may introduce into U.S. commerce partially complete vehicles for which they do not hold a certificate of conformity only as allowed by paragraph (b) of this section; however, the requirements of this section do not apply for tractors or vocational vehicles built before January 1, 2022, that are produced by a secondary vehicle manufacturer if they are excluded from the standards of this part under § 1037.150(c).

(b) The provisions of this paragraph (b) generally apply where the secondary vehicle manufacturer has substantial control over the design and assembly of emission controls. In unusual circumstances we may allow other secondary vehicle manufacturers to use these provisions. In determining whether a manufacturer has substantial control over the design and assembly of emission controls, we would consider the degree to which the secondary manufacturer would be able to ensure that the engine and vehicle will conform to the regulations in their final configurations.

(1) A secondary manufacturer may finish assembly of partially complete vehicles in the following cases:

(i) It obtains a vehicle that is not fully assembled with the intent to manufacture a complete vehicle in a certified configuration.

(ii) It obtains a vehicle with the intent to modify it to a certified configuration before it reaches the ultimate purchaser. For example, this may apply for converting a gasoline-fueled vehicle to operate on natural gas under the terms of a valid certificate.

(2) Manufacturers may introduce partially complete vehicles into U.S. commerce as described in this paragraph (b) if they have a written request for such vehicles from a secondary vehicle manufacturer that will finish the vehicle assembly and has certified the vehicle (or the vehicle has been exempted or excluded from the requirements of this part). The written request must include a statement that the secondary manufacturer has a certificate of conformity (or exemption/exclusion) for the vehicle and identify a valid vehicle family name associated with each vehicle model ordered (or the basis for an exemption/exclusion). The original vehicle manufacturer must apply a removable label meeting the requirements of 40 CFR 1068.45 that identifies the corporate name of the original manufacturer and states that the vehicle is exempt under the provisions of § 1037.622. The name of the certifying manufacturer must also be on the label or, alternatively, on the bill of lading that accompanies the vehicles during shipment. The original manufacturer may not apply a permanent emission control information label identifying the vehicle's eventual status as a certified vehicle.

(3) If you are the secondary manufacturer and you will hold the certificate, you must include the following information in your application for certification:

(i) Identify the original manufacturer of the partially complete vehicle or of the complete vehicle you will modify.

(ii) Describe briefly how and where final assembly will be completed. Specify how you have the ability to ensure that the vehicles will conform to the regulations in their final configuration. (**Note:** This section prohibits using the provisions of this paragraph (b) unless you have substantial control over the design and assembly of emission controls.)

(iii) State unconditionally that you will not distribute the vehicles without conforming to all applicable regulations.

(4) If you are a secondary manufacturer and you are already a certificate holder for other families, you may receive shipment of partially complete vehicles after you apply for a certificate of conformity but before the certificate's effective date. This exemption allows the original manufacturer to ship vehicles after you have applied for a certificate of conformity. Manufacturers may introduce partially complete vehicles into U.S. commerce as described in this paragraph (b)(4) if they have a written request for such vehicles from a secondary manufacturer stating that the

application for certification has been submitted (instead of the information we specify in paragraph (b)(2) of this section). We may set additional conditions under this paragraph (b)(4) to prevent circumvention of regulatory requirements.

(5) The provisions of this section also apply for shipping partially complete vehicles if the vehicle is covered by a valid exemption and there is no valid family name that could be used to represent the vehicle model. Unless we approve otherwise in advance, you may do this only when shipping engines to secondary manufacturers that are certificate holders. In this case, the secondary manufacturer must identify the regulatory cite identifying the applicable exemption instead of a valid family name when ordering engines from the original vehicle manufacturer.

(6) Both original and secondary manufacturers must keep the records described in this section for at least five years, including the written request for exempted vehicles and the bill of lading for each shipment (if applicable). The written request is deemed to be a submission to EPA.

(7) These provisions are intended only to allow secondary manufacturers to obtain or transport vehicles in the specific circumstances identified in this section so any exemption under this section expires when the vehicle reaches the point of final assembly identified in paragraph (b)(3)(ii) of this section.

(8) For purposes of this section, an allowance to introduce partially complete vehicles into U.S. commerce includes a conditional allowance to sell, introduce, or deliver such vehicles into commerce in the United States or import them into the United States. It does not include a general allowance to offer such vehicles for sale because this exemption is intended to apply only for cases in which the certificate holder already has an arrangement to purchase the vehicles from the original manufacturer. This exemption does not allow the original manufacturer to subsequently offer the vehicles for sale to a different manufacturer who will hold the certificate unless that second manufacturer has also complied with the requirements of this part. The exemption does not apply for any individual vehicles that are not labeled as specified in this section or which are shipped to someone who is not a certificate holder.

(9) We may suspend, revoke, or void an exemption under this section, as follows:

(i) We may suspend or revoke your exemption if you fail to meet the requirements of this section. We may suspend or revoke an exemption related to a specific secondary manufacturer if that manufacturer sells vehicles that are in not in a certified configuration in violation of the regulations. We may disallow this exemption for future shipments to the affected secondary manufacturer or set additional conditions to ensure that vehicles will be assembled in the certified configuration.

(ii) We may void an exemption for all the affected vehicles if you intentionally submit false or incomplete information or fail to keep and provide to EPA the records required by this section.

(iii) The exemption is void for a vehicle that is shipped to a company that is not a certificate holder or for a vehicle that is shipped to a secondary manufacturer that is not in compliance with the requirements of this section.

(iv) The secondary manufacturer may be liable for penalties for causing a prohibited act where the exemption is voided due to actions on the part of the secondary manufacturer.

(c) Provide instructions along with partially complete vehicles including all information necessary to ensure that an engine will be installed in its certified configuration.

§ 1037.630 Special purpose tractors.

(a) *General provisions.* This section allows a vehicle manufacturer to reclassify certain tractors as vocational tractors. Vocational tractors are treated as vocational vehicles and are exempt from the standards of § 1037.106. Note that references to ''tractors'' outside of this section mean non-vocational tractors.

(1) This allowance is intended only for vehicles that do not typically operate at highway speeds, or would otherwise not benefit from efficiency improvements designed for line-haul tractors. This allowance is limited to the following vehicle and application types:

(i) Low-roof tractors intended for intra-city pickup and delivery, such as those that deliver bottled beverages to retail stores.

(ii) Tractors intended for off-road operation (including mixed service operation), such as those with reinforced frames and increased ground clearance.

(iii) Model year 2020 and earlier tractors with a gross combination weight rating (GCWR) over 120,000 pounds. Note that tractors meeting the definition of ''heavy-haul'' in § 1037.801 may be certified to the heavy-haul standards in § 1037.106.

(2) Where we determine that a manufacturer is not applying this allowance in good faith, we may require the manufacturer to obtain preliminary approval before using this allowance.

(b) *Requirements.* The following requirements apply with respect to tractors reclassified under this section:

(1) The vehicle must fully conform to all requirements applicable to vocational vehicles under this part.

(2) Vehicles reclassified under this section must be certified as a separate vehicle family. However, they remain part of the vocational regulatory subcategory and averaging set that applies for their weight class.

(3) You must include the following additional statement on the vehicle's emission control information label under § 1037.135: ''THIS VEHICLE WAS CERTIFIED AS A VOCATIONAL TRACTOR UNDER 40 CFR 1037.630.''

(4) You must keep records for three years to document your basis for believing the vehicles will be used as described in paragraph (a)(1) of this section. Include in your application for certification a brief description of your basis.

(c) *Production limit.* No manufacturer may produce more than 21,000 vehicles under this section in any consecutive three model year period. This means you may not exceed 6,000 in a given model year if the combined total for the previous two years was 15,000. The production limit applies with respect to all Class 7 and Class 8 tractors certified or exempted as vocational tractors. Note that in most cases, the provisions of paragraph (a) of this section will limit the allowable number of vehicles to be a number lower than the production limit of this paragraph (c).

(d) *Off-road exemption.* All the provisions of this section apply for vocational tractors exempted under § 1037.631, except as follows:

(1) The vehicles are required to comply with the requirements of § 1037.631 instead of the requirements that would otherwise apply to vocational vehicles. Vehicles complying with the requirements of § 1037.631 and using an engine certified to the standards of 40 CFR part 1036 are deemed to fully conform to all requirements applicable to vocational vehicles under this part.

(2) The vehicles must be labeled as specified under § 1037.631 instead of as specified in paragraph (b)(3) of this section.

§ 1037.631 Exemption for vocational vehicles intended for off-road use.

This section provides an exemption from the greenhouse gas standards of this part for certain vocational vehicles intended to be used extensively in off-road environments such as forests, oil fields, and construction sites. This section does not exempt engines used in vocational vehicles from the standards of 40 CFR part 86 or part 1036. Note that you may not include these exempted vehicles in any credit calculations under this part. Note also that trailers designed specifically for off-road use are generally excluded from the requirements of this part under § 1037.5.

(a) *Qualifying criteria.* Vocational vehicles intended for off-road use are exempt without request, subject to the provisions of this section, if they are primarily designed to perform work off-road (such as in oil fields, mining, forests, or construction sites), and they meet at least one of the criteria of paragraph (a)(1) of this section and at least one of the criteria of paragraph (a)(2) of this section.

(1) The vehicle must have affixed components designed to work in an off-road environment (*i.e.*, hazardous material equipment or off-road drill equipment) or be designed to operate at low speeds such that it is unsuitable for normal highway operation.

(2) The vehicle must meet one of the following criteria:

(i) Have an axle that has a gross axle weight rating (GAWR) at or above 29,000 pounds.

(ii) Have a speed attainable in 2.0 miles of not more than 33 mph.

(iii) Have a speed attainable in 2.0 miles of not more than 45 mph, an unloaded vehicle weight that is not less than 95 percent of its gross vehicle weight rating, and no capacity to carry occupants other than the driver and operating crew.

(b) *Tractors.* The provisions of this section may apply for tractors only if each tractor qualifies as a vocational tractor under § 1037.630.

(c) *Recordkeeping and reporting.* (1) You must keep records to document that your exempted vehicle configurations meet all applicable requirements of this section. Keep these records for at least eight years after you stop producing the exempted vehicle model. We may review these records at any time.

(2) You must also keep records of the individual exempted vehicles you produce, including the vehicle identification number and a description of the vehicle configuration.

(3) Within 90 days after the end of each model year, you must send to the Designated Compliance Officer a report with the following information:

(i) A description of each exempted vehicle configuration, including an explanation of why it qualifies for this exemption.

(ii) The number of vehicles exempted for each vehicle configuration.

(d) *Labeling.* You must include the following additional statement on the vehicle's emission control information label under § 1037.135: ''THIS VEHICLE WAS EXEMPTED UNDER 40 CFR 1037.631.''

§ 1037.635 Glider kits.

Section 1037.601(a)(1) generally disallows the introduction into U.S. commerce of a new tractor or vocational vehicle (including a vehicle assembled from a glider kit) unless it has an engine that is certified to the standards that apply for the engine model year corresponding to the vehicle's date of manufacture. For example, for a vehicle with a 2020 date of manufacture, the engine must meet the standards that apply for model year 2020. Note that the engine may be from an earlier model year if the standards were identical. This section describes an exemption from the certification requirement that applies for qualifying manufacturers. Note that the Clean Air Act definition of ''manufacturer'' includes anyone who assembles motor vehicles, including entities that install engines in or otherwise complete assembly of glider kits.

(a) Vehicles conforming to the requirements in paragraphs (b) through (g) of this section are exempt from the emission standards of this part. Engines in such vehicles remain subject to the requirements of 40 CFR part 86 applicable for the engines' original model year, but are exempt from the standards of 40 CFR part 1036.

(b) You are eligible for an exemption under this section if you are a small manufacturer and you sold vehicles in 2014 under the provisions of § 1037.150(j). You must notify us of your plans to use this exemption before you introduce exempt vehicles into U.S. commerce. In your notification, you must identify your annual sales of such vehicles for calendar years 2010 through 2014. Vehicles you produce before notifying us, are not exempt under this section.

(c) In a given calendar year, you may sell up to 300 exempt vehicles under this section, or up to the highest annual sales volume you identify in paragraph (b) of this section, whichever is less.

(d) Identify the number of exempt vehicles you sold under this section for the prior calendar year in your annual report under § 1037.250,

(e) Include the following statement on the label required under § 1037.135: ''THIS VEHICLE AND ITS ENGINE ARE EXEMPT UNDER 40 CFR 1037.635.''

(f) This exemption is valid for a given vehicle only if you meet all the requirements and conditions of this section that apply with respect to that vehicle. Introducing such a vehicle into U.S. commerce without meeting all applicable requirements and conditions violates 40 CFR 1068.101(a)(1).

(g) Companies that are not small manufacturers may sell uncertified incomplete vehicles without engines to small manufacturers for the purpose of producing exempt vehicles under this section, subject to the provisions of § 1037.622.

§ 1037.640 Variable vehicle speed limiters.

This section specifies provisions that apply for vehicle speed limiters (VSLs) that you model under § 1037.520. This does not apply for VSLs that you do not model under § 1037.520.

(a) *General.* The regulations of this part do not constrain how you may design VSLs for your vehicles. For example, you may design your VSL to have a single fixed speed limit or a soft-top speed limit. You may also design your VSL to expire after accumulation of a predetermined number of miles. However, designs with soft tops or expiration features are subject to proration provisions under this section that do not apply to fixed VSLs that do not expire.

(b) *Definitions.* The following definitions apply for purposes of this section:

(1) Default speed limit means the speed limit that normally applies for the vehicle, except as follows:

(i) The default speed limit for adjustable VSLs must represent the speed limit that applies when the VSL is adjusted to its highest setting under paragraph (c) of this section.

(ii) For VSLs with soft tops, the default speed does not include speeds possible only during soft-top operation.

(iii) For expiring VSLs, the default does not include speeds that are possible only after expiration.

(2) Soft-top speed limit means the highest speed limit that applies during soft-top operation.

(3) Maximum soft-top duration means the maximum amount of time that a vehicle could operate above the default speed limit.

(4) Certified VSL means a VSL configuration that applies when a vehicle is new and until it expires.

(5) Expiration point means the mileage at which a vehicle's certified VSL expires (or the point at which tamper protections expire).

(6) Effective speed limit has the meaning given in paragraph (d) of this section.

(c) *Adjustments.* You may design your VSL to be adjustable; however, this may affect the value you use in GEM.

(1) Except as specified in paragraph (c)(2) of this section, any adjustments that can be made to the engine, vehicle, or their controls that change the VSL's actual speed limit are considered to be adjustable operating parameters. Compliance is based on the vehicle being adjusted to the highest speed limit within this range.

(2) The following adjustments are not adjustable parameters:

(i) Adjustments made only to account for changing tire size or final drive ratio.

(ii) Adjustments protected by encrypted controls or passwords.

(iii) Adjustments possible only after the VSL's expiration point.

(d) *Effective speed limit.* (1) For VSLs without soft tops or expiration points that expire before 1,259,000 miles, the effective speed limit is the highest speed limit that results by adjusting the VSL or other vehicle parameters consistent with the provisions of paragraph (c) of this section.

(2) For VSLs with soft tops and/or expiration points, the effective speed limit is calculated as specified in this paragraph (d)(2), which is based on 10 hours of operation per day (394 miles per day for day cabs and 551 miles per day for sleeper cabs). Note that this calculation assumes that a fraction of this operation is speed limited (3.9 hours and 252 miles for day cabs, and 7.3 hours and 474 miles for sleeper cabs). Use the following equation to calculate the effective speed limit, rounded to the nearest 0.1 mph:

$$\text{Effective speed} = ExF \cdot [STF \cdot STSL + (1\text{-}STF) \cdot DSL] + (1\text{-}ExF) \cdot 65 \text{ mph}$$

Where:

ExF = expiration point miles/1,259,000 miles.

STF = the maximum number of allowable soft top operation hours per day/3.9 hours for day cabs (or maximum miles per day/252), or the maximum number of allowable soft top operation hours per day/7.3 hours for sleeper cabs (or maximum miles per day/474).

STSL = the soft top speed limit.

DSL = the default speed limit.

§ 1037.645 In-use compliance with family emission limits (FELs).

Section 1037.225 describes how to change the FEL for a vehicle family during the model year. This section, which describes how you may ask us to increase a vehicle family's FEL after the end of the model year, is intended to address circumstances in which it is in the public interest to apply a higher in-use FEL based on forfeiting an appropriate number of emission credits.

(a) You may ask us to increase a vehicle family's FEL after the end of the model year if you believe some of your in-use vehicles exceed the CO_2 FEL that applied during the model year (or the CO_2 emission standard if the family did not generate or use emission credits). We may consider any available information in making our decision to approve or deny your request.

(b) If we approve your request under this section, you must apply emission credits to cover the increased FEL for all affected vehicles. Apply the emission credits as part of your credit demonstration for the current production year. Include the appropriate calculations in your final report under § 1037.730.

(c) Submit your request to the Designated Compliance Officer. Include the following in your request:

(1) Identify the names of each vehicle family that is the subject of your request. Include separate family names for different model years.

(2) Describe why your request does not apply for similar vehicle models or additional model years, as applicable.

(3) Identify the FEL that applied during the model year for each configuration and recommend replacement FELs for in-use vehicles; include a supporting rationale to describe how you determined the recommended replacement FELs.

(4) Describe whether the needed emission credits will come from averaging, banking, or trading.

(d) If we approve your request, we will identify one or more replacement FELs, as follows:

(1) Where your vehicle family includes more than one sub-family with different FELs, we may apply a higher FEL within the family than was applied to the vehicle's configuration in your final ABT report. For example, if your vehicle family included three sub-families, with FELs of 200 g/ton-mile, 210 g/ton-mile, and 220 g/ton-mile, we may apply a 220 g/ton-mile in-use FEL to vehicles that were originally designated as part of the 200 g/ton-mile or 210 g/ton-mile sub-families.

(2) Without regard to the number of sub-families in your certified vehicle family, we may specify one or more new sub-families with higher FELs than you included in your final ABT report. We may apply these higher FELs as in-use FELs for your vehicles. For example, if your vehicle family included three sub-families, with FELs of 200 g/ton-mile, 210 g/ton-mile, and 220 g/ton-mile, we may specify a new 230 g/ton-mile sub-family.

(3) Our selected values for the replacement FEL will reflect our best judgment to accurately reflect the actual in-use performance of your vehicles, consistent with the testing provisions specified in this part.

(4) We may apply the higher FELs to other vehicle families from the same or different model years to the extent they used equivalent emission controls. We may include any appropriate conditions with our approval.

(e) If we order a recall for a vehicle family under 40 CFR 1068.505, we will no longer approve a replacement FEL under this section for any of your vehicles from that vehicle family, or from any other vehicle family that relies on equivalent emission controls.

§ 1037.650 Tire manufacturers.

This section describes how the requirements of this part apply with respect to tire manufacturers that choose to provide test data or emission warranties for purposes of this part.

(a) *Testing.* You are responsible as follows for test tires and emission test results that you provide to vehicle manufacturers for the purpose of the manufacturer submitting them to EPA for certification under this part:

(1) Such test results are deemed under § 1037.825 to be submissions to EPA. This means that you may be subject to criminal penalties under 18 U.S.C. 1001 if you knowingly submit false test results to the manufacturer.

(2) You may not cause a vehicle manufacturer to violate the regulations by rendering inaccurate emission test results you provide (or emission test results from testing of test tires you provide) to the vehicle manufacturer.

(3) Your provision of test tires and emission test results to vehicle manufacturers for the purpose of certifying under this part is deemed to be an agreement to provide tires to EPA for confirmatory testing under § 1037.201.

(b) *Warranty.* You may contractually agree to process emission warranty claims on behalf of the manufacturer certifying the vehicle with respect to tires you produce.

(1) Your fulfillment of the warranty requirements of this part is deemed to fulfill the vehicle manufacturer's warranty obligations under this part with respect to tires you warrant.

(2) You may not cause a vehicle manufacturer to violate the regulations by failing to fulfill the emission warranty requirements that you contractually agreed to fulfill.

§ 1037.655 Post-useful life vehicle modifications.

This section specifies vehicle modifications that may occur in certain circumstances after a vehicle reaches the end of its regulatory useful life. It does not apply with respect to modifications that occur within the useful life period. It also does not apply with respect to engine modifications or recalibrations. Note that many such modifications to the vehicle during the useful life and to the engine at any time are presumed to violate 42 U.S.C. 7522(a)(3)(A).

(a) *General.* Except as allowed by this section, it is prohibited for any person to remove or render inoperative any emission control device installed to comply with the requirements of this part 1037.

(b) *Allowable modifications.* You may modify a vehicle for the purpose of reducing emissions, provided you have a reasonable technical basis for knowing that such modification will not increase emissions of any other pollutant. Reasonable technical basis has the meaning given in 40 CFR 1068.30. This generally requires you to have information that would lead an engineer or other person familiar with engine and vehicle design and function to reasonably believe that the modifications will not increase emissions of any regulated pollutant.

(c) *Examples of allowable modifications.* The following are examples of allowable modifications:

(1) It is generally allowable to remove tractor roof fairings after the end of the vehicle's useful life if the vehicle will no longer be used primarily to pull box trailers.

(2) Other fairings may be removed after the end of the vehicle's useful life if the vehicle will no longer be used significantly on highways with vehicle speed of 55 miles per hour or higher.

(d) *Examples of prohibited modifications.* The following are examples of modifications that are not allowable:

(1) No person may disable a vehicle speed limiter prior to its expiration point.

(2) No person may remove aerodynamic fairings from tractors that are used primarily to pull box trailers on highways.

§ 1037.660 Automatic engine shutdown systems.

This section specifies requirements that apply for certified automatic engine shutdown (AES) systems modeled under § 1037.520. It does not apply for AES systems you do not model under § 1037.520.

(a) *Minimum requirements.* Your AES system must meet all of the requirements of this paragraph (a) to be modeled under § 1037.520. The system must shut down the engine within 300 seconds when all the following conditions are met:

(1) The transmission is set in neutral with the parking brake engaged (or the transmission is set to park if so equipped).

(2) The operator has not reset the system timer within the 300 seconds by changing the position of the accelerator, brake, or clutch pedal; or by some other mechanism we approve.

(3) None of the override conditions of paragraph (b) of this section are met.

(b) *Override conditions.* The system may delay shutting the engine down while any of the conditions of this paragraph (b) apply. Engines equipped with auto restart may restart during override conditions. Note that these conditions allow the system to delay shutdown or restart, but do not allow it to reset the timer. The system may delay shutdown—

(1) While an exhaust emission control device is regenerating. The period considered to be regeneration for purposes of this allowance must be consistent with good engineering judgment and may differ in length from the period considered to be regeneration for other purposes. For example, in some cases it may be appropriate to include a cool down period for this purpose but not for infrequent regeneration adjustment factors.

(2) If necessary while servicing the vehicle, provided the deactivation of the AES system is accomplished using a diagnostic scan tool. The system must be automatically reactivated when the engine is shutdown for more than 60 minutes.

(3) If the vehicle's main battery state-of-charge is not sufficient to allow the main engine to be restarted.

(4) If the external ambient temperature reaches a level below which or above which the cabin temperature cannot be maintained within reasonable heat or cold exposure threshold limit values for the health and safety of the operator (not merely comfort).

(5) If the vehicle's engine coolant temperature is too low according to the manufacturer's engine protection guidance. This may also apply for fuel or oil temperatures. This allows the engine to continue operating until it reaches a predefined temperature at which the shutdown sequence of paragraph (a) of this section would resume.

(6) The system may delay shutdown while the vehicle's main engine is operating in power take-off (PTO) mode. For purposes of this paragraph (b)(6), an engine is considered to be in PTO mode when a switch or setting designating PTO mode is enabled.

(c) *Adjustments to AES systems.* (1) The AES system may include an expiration point (in miles) after which the AES system may be disabled. If your vehicle is equipped with an AES system that expires before 1,259,000 miles, adjust the model input as follows, rounded to the nearest 0.1 g/ton-mile: AES Input = 5 g CO_2/ton-mile × (miles at expiration/1,259,000 miles).

(2) For AES systems designed to limit idling to a specific number of hours less than 1,800 hours over any 12-month period, calculate an adjusted AES input using the following equation, rounded to the nearest 0.1 g/ton-mile: AES Input = 5 g CO_2/ton-mile × (1 − (maximum allowable number of idling hours per year/1,800 hours)). This is an annual allowance that starts when the vehicle is new and resets every 12 months after that. Manufacturers may propose an alternative method based on operating hours or miles instead of years.

(d) *Adjustable parameters.* Provisions that apply generally with respect to adjustable parameters also apply to the AES system operating parameters, except the following are not considered to be adjustable parameters:

(1) Accelerator, brake, and clutch pedals, with respect to resetting the idle timer. Parameters associated with other timer reset mechanisms we approve are also not adjustable parameters.

(2) Bypass parameters allowed for vehicle service under paragraph (b)(2) of this section.

(3) Parameters that are adjustable only after the expiration point.

§ 1037.665 In-use tractor testing.

Manufacturers with U.S.-directed production volumes of greater than 20,000 tractors must perform in-use testing as described in this section.

(a) The following test requirements apply beginning in model year 2021:

(1) Each year, select for testing three sleeper cabs and two day cabs certified to Phase 1 or Phase 2 standards. If we do not identify certain vehicle configurations for your testing, select models that you project to be among your 12 highest-selling vehicle configurations for the given year.

(2) Set up the tractors on a chassis dynamometer and operate them over all applicable duty cycles from § 1037.510(a). You may use emission-measurement systems meeting the specifications of 40 CFR part 1065, subpart J. Calculate coefficients for the road-load force equation as described in Section 10 of SAE J1263 or Section 11 of SAE J2263 (both incorporated by reference in § 1037.810). Use standard

payload. Measure emissions of NO_X, PM, CO, NMHC, CO_2, CH_4, and N_2O. Determine emission levels in g/hour for the idle test and g/ton-mile for other duty cycles.

(b) Send us an annual report with your test results for each duty cycle and the corresponding GEM results. We may make your test data publicly available.

Subpart H—Averaging, Banking, and Trading for Certification

§ 1037.701 General provisions.

(a) You may average, bank, and trade emission credits for purposes of certification as described in this subpart and in subpart B of this part to show compliance with the standards of §§ 1037.105 through 1037.107. Participation in this program is voluntary.

(b) The definitions of Subpart I of this part apply to this subpart. The following definitions also apply:

(1) *Actual emission credits* means emission credits you have generated that we have verified by reviewing your final report.

(2) *Averaging set* means a set of vehicles in which emission credits may be exchanged. Credits generated by one vehicle may only be used by other vehicles in the same averaging set. Note that an averaging set may comprise more than one regulatory subcategory. See § 1037.740.

(3) *Broker* means any entity that facilitates a trade of emission credits between a buyer and seller.

(4) *Buyer* means the entity that receives emission credits as a result of a trade.

(5) *Reserved emission credits* means emission credits you have generated that we have not yet verified by reviewing your final report.

(6) *Seller* means the entity that provides emission credits during a trade.

(7) *Standard* means the emission standard that applies under subpart B of this part for vehicles not participating in the ABT program of this subpart.

(8) *Trade* means to exchange emission credits, either as a buyer or seller.

(c) Emission credits may be exchanged only within an averaging set as specified in § 1037.740.

(d) You may not use emission credits generated under this subpart to offset any emissions that exceed an FEL or standard, except as allowed by § 1037.645.

(e) You may use either of the following approaches to retire or forego emission credits:

(1) You may trade emission credits generated from any number of your vehicles to the vehicle purchasers or other parties to retire the credits. Identify any such credits in the reports described in § 1037.730. Vehicles must comply with the applicable FELs even if you donate or sell the corresponding emission credits under this paragraph (e). Those credits may no longer be used by anyone to demonstrate compliance with any EPA emission standards.

(2) You may certify a family using an FEL below the emission standard as described in this part and choose not to generate emission credits for that family. If you do this, you do not need to calculate emission credits for those families and you do not need to submit or keep the associated records described in this subpart for that family.

(f) Emission credits may be used in the model year they are generated. Surplus emission credits may be banked for future model years. Surplus emission credits may sometimes be used for past model years, as described in § 1037.745.

(g) You may increase or decrease an FEL during the model year by amending your application for certification under § 1037.225. The new FEL may apply only to vehicles you have not already introduced into commerce.

(h) See § 1037.740 for special credit provisions that apply for credits generated under § 1037.104(d)(7), § 1037.615 or 40 CFR 1036.615.

(i) Unless the regulations explicitly allow it, you may not calculate credits more than once for any emission reduction. For example, if you generate CO_2 emission credits for a given hybrid vehicle under this part, no one may generate CO_2 emission credits for the hybrid engine under 40 CFR part 1036. However, credits could be generated for identical engine used in vehicles that did not generate credits under this part.

(j) You may use emission credits generated under the Phase 1 standards when certifying vehicles to Phase 2 standards. No credit adjustments are required other than corrections for different useful lives.

§ 1037.705 Generating and calculating emission credits.

(a) The provisions of this section apply separately for calculating emission credits for each pollutant.

(b) For each participating family or subfamily, calculate positive or negative emission credits relative to the otherwise applicable emission standard. Calculate positive emission credits for a family or subfamily that has an FEL below the standard. Calculate negative emission credits for a family or subfamily that has an FEL above the standard. Sum your positive and negative credits for the model year before rounding. Round the sum of emission credits to the nearest megagram (Mg), using consistent units with the following equation:

$$\textit{Emission credits}\ (\text{Mg}) = (\textit{Std}–\textit{FEL}) \cdot (\textit{PL}) \cdot (\textit{Volume}) \cdot (\textit{UL}) \cdot (10^{-6})$$

Where:

Std = the emission standard associated with the specific regulatory subcategory (g/ton-mile).

FEL = the family emission limit for the vehicle subfamily (g/ton-mile).

PL = standard payload, in tons.

Volume = U.S.-directed production volume of the vehicle subfamily. For example, if you produce three configurations with the same FEL, the subfamily production volume would be the sum of the production volumes for these three configurations.

UL = useful life of the vehicle, in miles, as described in § 1037.105 and § 1037.106. Use 250,000 miles for trailers.

(c) As described in § 1037.730, compliance with the requirements of this subpart is determined at the end of the model year based on actual U.S.-directed production volumes. Keep appropriate records to document these production volumes. Do not include any of the following vehicles to calculate emission credits:

(1) Vehicles that you do not certify to the CO_2 standards of this part because they are permanently exempted under subpart G of this part or under 40 CFR part 1068.

(2) Exported vehicles.

(3) Vehicles not subject to the requirements of this part, such as those excluded under § 1037.5.

(4) Any other vehicles, where we indicate elsewhere in this part 1037 that they are not to be included in the calculations of this subpart.

§ 1037.710 Averaging.

(a) Averaging is the exchange of emission credits among your vehicle families. You may average emission credits only within the same averaging set.

(b) You may certify one or more vehicle families (or subfamilies) to an FEL above the applicable standard, subject to any applicable FEL caps and other provisions in subpart B of this part, if you show in your application for certification that your projected balance of all emission-credit transactions in that model year is greater than or equal to zero or that a negative balance is allowed under § 1037.745.

(c) If you certify a vehicle family to an FEL that exceeds the otherwise applicable standard, you must obtain enough emission credits to offset the vehicle family's deficit by the due date for the final report required in § 1037.730. The emission credits used to address the deficit may come from your other vehicle families that generate emission credits in the same model year (or from later model years as specified in § 1037.745), from emission credits you have banked from previous model years, or from emission credits generated in the same or previous model years that you obtained through trading. Note that the option for using banked or traded credits does not apply for trailers.

§ 1037.715 Banking.

(a) Banking is the retention of surplus emission credits by the manufacturer generating the emission credits for use in future model years for averaging or trading. Note that § 1037.107 does not allow banking for trailers.

(b) You may designate any emission credits you plan to bank in the reports you submit under § 1037.730 as reserved credits. During the model year and before the due date for the final report, you may designate your reserved emission credits for averaging or trading.

(c) Reserved credits become actual emission credits when you submit your final report. However, we may revoke these emission credits if we are unable to verify them after reviewing your reports or auditing your records.

(d) Banked credits retain the designation of the averaging set in which they were generated.

§ 1037.720 Trading.

(a) Trading is the exchange of emission credits between manufacturers, or the transfer of credits to another party to retire them. You may use traded emission credits for averaging, banking, or further trading transactions. Traded emission credits remain subject to the averaging-set restrictions based on the averaging set in which they were generated. Note that § 1037.107 does not allow trading for trailers.

(b) You may trade actual emission credits as described in this subpart. You may also trade reserved emission credits, but we may revoke these emission credits based on our review of your records or reports or those of the company with which you traded emission credits. You may trade banked credits within an averaging set to any certifying manufacturer.

(c) If a negative emission credit balance results from a transaction, both the buyer and seller are liable, except in cases we deem to involve fraud. See § 1037.255(e) for cases involving fraud. We may void the certificates of all vehicle families participating in a trade that results in a manufacturer having a negative balance of emission credits. See § 1037.745.

§ 1037.725 What must I include in my application for certification?

(a) You must declare in your application for certification your intent to use the provisions of this subpart for each vehicle family that will be certified using the ABT program. You must also declare the FELs you select for the vehicle family or subfamily for each pollutant for which you are using the ABT program. Your FELs must comply with the specifications of subpart B of this part, including the FEL caps. FELs must be expressed to the same number of decimal places as the applicable standards.

(b) Include the following in your application for certification:

(1) A statement that, to the best of your belief, you will not have a negative balance of emission credits for any averaging set when all emission credits are calculated at the end of the year; or a statement that you will have a negative balance of emission credits for one or more averaging sets but that it is allowed under § 1037.745.

(2) Calculations of projected emission credits (positive or negative) based on projected U.S.-directed production volumes. We may require you to include similar calculations from your other vehicle families to project your net credit balances for the model year. If you project negative emission credits for a family or subfamily, state the source of positive emission credits you expect to use to offset the negative emission credits.

§ 1037.730 ABT reports.

(a) If any of your vehicle families are certified using the ABT provisions of this subpart, you must send a final report by March 31 following the end of the model year. You may ask us to extend the deadline for the final report to April 30.

(b) Your final report must include the following information for each vehicle family participating in the ABT program:

(1) Vehicle-family and subfamily designations, and averaging set.

(2) The regulatory subcategory and emission standards that would otherwise apply to the vehicle family.

(3) The FEL for each pollutant. If you change the FEL after the start of production, identify the date that you started using the new FEL and/or give the vehicle identification number for the first vehicle covered by the new FEL. In this case, identify each applicable FEL and calculate the positive or negative emission credits as specified in § 1037.225.

(4) The projected and actual U.S.-directed production volumes for the model year. If you changed an FEL during the model year, identify the actual U.S.-directed production volume associated with each FEL.

(5) Useful life.

(6) Calculated positive or negative emission credits for the whole vehicle family. Identify any emission credits that you traded, as described in paragraph (d)(1) of this section.

(7) If you have a negative credit balance for the averaging set in the given model year, specify whether the vehicle family (or certain subfamilies with the vehicle family) have a credit deficit for the year. Consider for example, a manufacturer with three vehicle families (''A'', ''B'', and ''C'') in a given averaging set. If family A generates enough credits to offset the negative credits of family B but not enough to also offset the negative credits of family C (and the manufacturer has no banked credits in the averaging set), the manufacturer may designate families A and B as having no deficit for the model year, provided it designates family C as having a deficit for the model year.

(c) Your final report must include the following additional information:

(1) Show that your net balance of emission credits from all your participating vehicle families in each averaging set in the applicable model year is not negative, except as allowed under § 1037.745. Your credit tracking must account for the limitation on credit life under § 1037.40(c).

(2) State whether you will retain any emission credits for banking. If you choose to retire emission credits that would otherwise be eligible for banking, identify the families that generated the emission credits, including the number of emission credits from each family.

(3) State that the report's contents are accurate.

(4) Identify the technologies that make up the certified configuration associated with each vehicle identification number. You may identify this as a range of identification numbers for vehicles involving a single, identical certified configuration.

(d) If you trade emission credits, you must send us a report within 90 days after the transaction, as follows:

(1) As the seller, you must include the following information in your report:

(i) The corporate names of the buyer and any brokers.

(ii) A copy of any contracts related to the trade.

(iii) The vehicle families that generated emission credits for the trade, including the number of emission credits from each family.

(2) As the buyer, you must include the following information in your report:

(i) The corporate names of the seller and any brokers.

(ii) A copy of any contracts related to the trade.

(iii) How you intend to use the emission credits, including the number of emission credits you intend to apply to each vehicle family (if known).

(e) Send your reports electronically to the Designated Compliance Officer using an approved information format. If you want to use a different format, send us a written request with justification for a waiver.

(f) Correct errors in your final report as follows:

(1) If you or we determine before the due date for the final report that errors mistakenly decreased your balance of emission credits, you may correct the errors and recalculate the balance of emission credits. You may not make these corrections for errors that are determined after the due date for the final report. If you report a negative balance of emission credits, we may disallow corrections under this paragraph (f)(1).

(2) If you or we determine anytime that errors mistakenly increased your balance of emission credits, you must correct the errors and recalculate the balance of emission credits.

§ 1037.735 Recordkeeping.

(a) You must organize and maintain your records as described in this section.

(b) Keep the records required by this section for at least eight years after the due date for the final report. You may not use emission credits for any vehicles if you do not keep all the records required under this section. You must therefore keep these records to continue to bank valid credits.

(c) Keep a copy of the reports we require in §§ 1037.725 and 1037.730.

(d) Keep records of the vehicle identification number for each vehicle you produce. You may identify these numbers as a range. If you change the FEL after the start of production, identify the date you started using each FEL and the range of vehicle identification numbers associated with each FEL. You must also identify the purchaser and destination for each vehicle you produce to the extent this information is available.

(e) We may require you to keep additional records or to send us relevant information not required by this section in accordance with the Clean Air Act.

§ 1037.740 Restrictions for using emission credits.

The following restrictions apply for using emission credits:

(a) *Averaging sets.* Except as specified in paragraph (b) of this section, emission credits may be exchanged only within an averaging set. The following principal averaging sets apply for vehicles subject to this subpart:

(1) Class 2b through 5 vehicles that are subject to the standards of § 1037.105.

(2) Class 6 and 7 vehicles.

(3) Class 8 vehicles.

(4) Long box van trailers.

(5) Short box van trailers.

(6) Long refrigerated box van trailers.

(7) Short refrigerated box van trailers.

(8) Note that other separate averaging sets also apply for emission credits not related to this part. For example, vehicles certified to the greenhouse gas standards of 40 CFR 86.1819 comprise a single averaging set. Separate averaging sets also apply for engines under 40 CFR part 1036, including engines used in vehicles subject to this subpart.

(b) *Credits from hybrid vehicles and other advanced technologies.* Credits you generate under § 1037.615 in Phase 1 may be used for any of the averaging sets identified in paragraph (a) of this section; you may also use those credits to demonstrate compliance with the CO_2 emission standards in 40 CFR 86.1819 and 40 CFR part 1036. Similarly, you may use advanced-technology credits generated under 40 CFR 86.1819–14(k)(7) or 40 CFR 1036.615 to demonstrate compliance with the CO_2 standards in this part.

(1) The maximum amount of credits you may bring into the following service class groups is 60,000 Mg per model year:

(i) Spark-ignition engines, light heavy-duty compression-ignition engines, and light heavy-duty vehicles. This group comprises the averaging set listed in paragraphs (a)(1) of this section and the averaging set listed in 40 CFR 1036.740(a)(1) and (2).

(ii) Medium heavy-duty compression-ignition engines and medium heavy-duty vehicles. This group comprises the averaging sets listed in paragraph (a)(2) of this section and 40 CFR 1036.740(a)(3).

(iii) Heavy heavy-duty compression-ignition engines and heavy heavy-duty vehicles. This group comprises the averaging sets listed in paragraph (a)(3) of this section and 40 CFR 1036.740(a)(4).

(2) Paragraph (b)(1) of this section does not limit the advanced technology credits that can be used within a service class group if they were generated in that same service class group.

(c) *Credit life.* Banked credits may be used only for five model years after the year in which they are generated. For example, credits you generate in model year 2018 may be used to demonstrate compliance with emission standards only through model year 2023.

(d) *Other restrictions.* Other sections of this part specify additional restrictions for using emission credits under certain special provisions.

§ 1037.745 End-of-year CO_2 credit deficits.

Except as allowed by this section, we may void the certificate of any vehicle family certified to an FEL above the applicable standard for which you do not have sufficient credits by the deadline for submitting the final report.

(a) Your certificate for a vehicle family for which you do not have sufficient CO_2 credits will not be void if you remedy the deficit with surplus credits within three model years (this applies equally for tractors, trailers, and vocational vehicles). For example, if you have a credit deficit of 500 Mg for a vehicle family at the end of model year 2015, you must generate (or otherwise obtain) a surplus of at least 500 Mg in that same averaging set by the end of model year 2018.

(b) You may not bank or trade away CO_2 credits in the averaging set in any model year in which you have a deficit.

(c) You may apply only surplus credits to your deficit. You may not apply credits to a deficit from an earlier model year if they were generated in a model year for which any of your vehicle families for that averaging set had an end-of-year credit deficit.

(d) If you do not remedy the deficit with surplus credits within three model years, we may void your certificate for that vehicle family. Note that voiding a certificate applies *ab initio.* Where the net deficit is less than the total amount of negative credits originally generated by the family, we will void the certificate only with respect to the number of vehicles needed to reach the amount of the net deficit. For example, if the original vehicle family generated 500 Mg of negative credits, and the manufacturer's net deficit after three years was 250 Mg, we would void the certificate with respect to half of the vehicles in the family.

(e) For purposes of calculating the statute of limitations, the following actions are all considered to occur at the expiration of the deadline for offsetting a deficit as specified in paragraph (a) of this section:

(1) Failing to meet the requirements of paragraph (a) of this section.

(2) Failing to satisfy the conditions upon which a certificate was issued relative to offsetting a deficit.

(3) Selling, offering for sale, introducing or delivering into U.S. commerce, or importing vehicles that are found not to be covered by a certificate as a result of failing to offset a deficit.

§ 1037.750 What can happen if I do not comply with the provisions of this subpart?

(a) For each vehicle family participating in the ABT program, the certificate of conformity is conditioned upon full compliance with the provisions of this subpart during and after the model year. You are responsible to establish to our satisfaction that you fully comply with applicable requirements. We may void the certificate of conformity for a vehicle family if you fail to comply with any provisions of this subpart.

(b) You may certify your vehicle family or subfamily to an FEL above an applicable standard based on a projection that you will have enough emission credits to offset the deficit for the vehicle family. See § 1037.745 for provisions specifying what happens if you cannot show in your final report that you have enough actual emission credits to offset a deficit for any pollutant in a vehicle family.

(c) We may void the certificate of conformity for a vehicle family if you fail to keep records, send reports, or give us information we request. Note that failing to keep records, send reports, or give us information we request is also a violation of 42 U.S.C. 7522(a)(2).

(d) You may ask for a hearing if we void your certificate under this section (see § 1037.820).

§ 1037.755 Information provided to the Department of Transportation.

After receipt of each manufacturer's final report as specified in § 1037.730 and completion of any verification testing required to validate the manufacturer's submitted final data, we will issue a report to the Department of Transportation with CO_2 emission information and will verify the accuracy of each manufacturer's equivalent fuel consumption data required by NHTSA under 49 CFR 535.8. We will send a report to DOT for each vehicle manufacturer based on each regulatory category and subcategory, including sufficient information for NHTSA to determine fuel consumption and associated credit values. See 49 CFR 535.8 to determine if NHTSA deems submission of this information to EPA to also be a submission to NHTSA.

Subpart I—Definitions and Other Reference Information

§ 1037.801 Definitions.

The following definitions apply to this part. The definitions apply to all subparts unless we note otherwise. All undefined terms have the meaning the Act gives to them. The definitions follow:

Act means the Clean Air Act, as amended, 42 U.S.C. 7401–7671q.

Adjustable parameter means any device, system, or element of design that someone can adjust (including those which are difficult to access) and that, if adjusted, may affect measured or modeled emissions (as applicable). You may ask us to exclude a parameter that is difficult to access if it cannot be adjusted to affect emissions without significantly degrading vehicle performance, or if you otherwise show us that it will not be adjusted in a way that affects emissions during in-use operation.

Adjusted Loaded Vehicle Weight means the numerical average of vehicle curb weight and GVWR.

Advanced technology means vehicle technology certified under 40 CFR 86.1819–14(k)(7), 40 CFR 1036.615, or § 1037.615.

Aftertreatment means relating to a catalytic converter, particulate filter, or any other system, component, or technology mounted downstream of the exhaust valve (or exhaust port) whose design function is to decrease emissions in the vehicle exhaust before it is exhausted to the environment. Exhaust-gas recirculation (EGR) and turbochargers are not aftertreatment.

Aircraft means any vehicle capable of sustained air travel more than 100 feet off the ground.

Alcohol-fueled vehicle means a vehicle that is designed to run using an alcohol fuel. For purposes of this definition, alcohol fuels do not include fuels with a nominal alcohol content below 25 percent by volume.

Alternative fuel conversion has the meaning given for clean alternative fuel conversion in 40 CFR 85.502.

Ambulance has the meaning given in 40 CFR 86.1803.

Amphibious vehicle means a motor vehicle that is also designed for operation on water.

A to B testing means testing performed in pairs to allow comparison of two vehicles or other test articles. Back-to-back tests are performed on Article A and Article B, changing only the variable(s) of interest for the two tests.

Automatic tire inflation system means a system installed on a vehicle to keep each tire inflated to within 10 percent of the target value with no operator input.

Auxiliary emission control device means any element of design that senses temperature, motive speed, engine rpm, transmission gear, or any other parameter for the purpose of activating, modulating, delaying, or deactivating the operation of any part of the emission control system.

Averaging set has the meaning given in § 1037.701.

Axle ratio or Drive axle ratio, k_a, means the dimensionless number representing the angular speed of the transmission output shaft divided by the angular speed of the drive axle.

Basic vehicle frontal area means the area enclosed by the geometric projection of the basic vehicle along the longitudinal axis onto a plane perpendicular to the longitudinal axis of the vehicle, including tires but excluding mirrors and air deflectors.

Calibration means the set of specifications and tolerances specific to a particular design, version, or application of a component or assembly capable of functionally describing its operation over its working range.

Carryover means relating to certification based on emission data generated from an earlier model year.

Certification means relating to the process of obtaining a certificate of conformity for a vehicle family that complies with the emission standards and requirements in this part.

Certified emission level means the highest deteriorated emission level in a vehicle subfamily for a given pollutant from either transient or steady-state testing.

Class means relating to GVWR classes for vehicles other than trailers, as follows:

(1) *Class 2b* means heavy-duty motor vehicles at or below 10,000 pounds GVWR.

(2) *Class 3* means heavy-duty motor vehicles above 10,000 pounds GVWR but at or below 14,000 pounds GVWR.

(3) *Class 4* means heavy-duty motor vehicles above 14,000 pounds GVWR but at or below 16,000 pounds GVWR.

(4) *Class 5* means heavy-duty motor vehicles above 16,000 pounds GVWR but at or below 19,500 pounds GVWR.

(5) *Class 6* means heavy-duty motor vehicles above 19,500 pounds GVWR but at or below 26,000 pounds GVWR.

(6) *Class 7* means heavy-duty motor vehicles above 26,000 pounds GVWR but at or below 33,000 pounds GVWR.

(7) *Class 8* means heavy-duty motor vehicles above 33,000 pounds GVWR.

Complete vehicle has the meaning given in the definition of *vehicle* in this section.

Compression-ignition has the meaning given in § 1037.101.

Date of manufacture means the date on which the certifying vehicle manufacturer completes its manufacturing operations, except as follows:

(1) Where the certificate holder is an engine manufacturer that does not manufacture the chassis, the date of manufacture of the vehicle is based on the date assembly of the vehicle is completed.

(2) We may approve an alternate date of manufacture based on the date on which the certifying (or primary) manufacturer completes assembly at the place of main assembly, consistent with the provisions of § 1037.601 and 49 CFR 567.4.

Day cab means a type of tractor cab that is not a sleeper cab or a heavy-haul tractor cab.

Designated Compliance Officer means one of the following:

(1) For compression-ignition engines, *Designated Compliance Officer* means Director, Diesel Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *complianceinfo@epa.gov; epa.gov/otaq/verify.*

(2) For spark-ignition engines, *Designated Compliance Officer* means Director, Gasoline Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *nonroad-si-cert@epa.gov.*

Deteriorated emission level means the emission level that results from applying the appropriate deterioration factor to the official emission result of the emission-data vehicle. Note that where no deterioration factor applies, references in this part to the *deteriorated emission level* mean the official emission result.

Deterioration factor means the relationship between the highest emissions during the useful life and emissions at the low-hour test point, expressed in one of the following ways:

(1) For multiplicative deterioration factors, the ratio of the highest emissions to emissions at the low-hour test point.

(2) For additive deterioration factors, the difference between the highest emissions and emissions at the low-hour test point.

Driver model means an automated controller that simulates a person driving a vehicle.

Dual-fuel means relating to a vehicle or engine designed for operation on two different fuels but not on a continuous mixture of those fuels. For purposes of this part, such a vehicle or engine remains a dual-fuel vehicle or engine even if it is designed for operation on three or more different fuels.

Electric vehicle means a vehicle that does not include an engine, and is powered solely by an external source of electricity and/or solar power. Note that this does not include electric hybrid or fuel-cell vehicles that use a chemical fuel such as gasoline, diesel fuel, or hydrogen. Electric vehicles may also be referred to as all-electric vehicles to distinguish them from hybrid vehicles.

Emergency vehicle means a vehicle that is an ambulance or a fire truck.

Emission control system means any device, system, or element of design that controls or reduces the emissions of regulated pollutants from a vehicle.

Emission-data component means a vehicle component that is tested for certification. This includes vehicle components tested to establish deterioration factors.

Emission-data vehicle means a vehicle (or vehicle component) that is tested for certification. This includes vehicles tested to establish deterioration factors.

Emission-related maintenance means maintenance that substantially affects emissions or is likely to substantially affect emission deterioration.

Excluded means relating to vehicles that are not subject to some or all of the requirements of this part as follows:

(1) A vehicle that has been determined not to be a ''motor vehicle'' is excluded from this part.

(2) Certain vehicles are excluded from the requirements of this part under § 1037.5.

(3) Specific regulatory provisions of this part may exclude a vehicle generally subject to this part from one or more specific standards or requirements of this part.

Exempted has the meaning given in 40 CFR 1068.30.

Family emission limit (FEL) means an emission level declared by the manufacturer to serve in place of an otherwise applicable emission standard under the ABT program in subpart H of this part. The family emission limit must be expressed to the same number of decimal places as the emission standard it replaces. Note that an FEL may apply as a ''subfamily'' emission limit.

Final drive ratio, k_d, means the dimensionless number representing the angular speed of the transmission input shaft divided by the angular speed of the drive axle when the vehicle is operating in its highest available gear. The final drive ratio is the transmission gear ratio (in the highest available gear) multiplied by the drive axle ratio.

Fire truck has the meaning given in 40 CFR 86.1803.

Flexible-fuel means relating to an engine designed for operation on any mixture of two or more different fuels.

Fuel system means all components involved in transporting, metering, and mixing the fuel from the fuel tank to the combustion chamber(s), including the fuel tank, fuel pump, fuel filters, fuel lines, carburetor or fuel-injection components, and all fuel-system vents. It also includes components for controlling evaporative emissions, such as fuel caps, purge valves, and carbon canisters.

Fuel type means a general category of fuels such as diesel fuel or natural gas. There can be multiple grades within a single fuel type, such as high-sulfur or low-sulfur diesel fuel.

Gaseous fuel means a fuel that has a boiling point below 20 °C.

Gear ratio or Transmission gear ratio, k_g, means the dimensionless number representing the angular velocity of the transmission's input shaft divided by the angular velocity of the transmission's output shaft when the transmission is operating in a specific gear.

Glider kit means any of the following:

(1) A new vehicle that is incomplete because it lacks an engine, transmission, or axle.

(2) A new vehicle produced with a used engine (including a rebuilt or remanufactured engine).

(3) Any other new equipment that is intended to become a motor vehicle with a previously used engine (including a rebuilt or remanufactured engine).

Glider vehicle means a new vehicle produced with a used engine.

Good engineering judgment has the meaning given in 40 CFR 1068.30. See 40 CFR 1068.5 for the administrative process we use to evaluate good engineering judgment.

Gross axle weight rating (GAWR) means the value specified by the vehicle manufacturer as the maximum weight of a loaded axle or set of axles, consistent with good engineering judgment.

Gross combination weight rating (GCWR) means the value specified by the vehicle manufacturer as the maximum weight of a loaded vehicle and trailer, consistent with good engineering judgment. For example, compliance with SAE J2807 is generally considered to be consistent with good engineering judgment, especially for Class 3 and smaller vehicles.

Gross vehicle weight rating (GVWR) means the value specified by the vehicle manufacturer as the maximum design loaded weight of a single vehicle, consistent with good engineering judgment.

Heavy-duty engine means any engine used for (or for which the engine manufacturer could reasonably expect to be used for) motive power in a heavy-duty vehicle.

Heavy-duty vehicle means any trailer and any other motor vehicle that has a GVWR above 8,500 pounds, a curb weight above 6,000 pounds, or a basic vehicle frontal area greater than 45 square feet.

Heavy-haul tractor means a tractor with GCWR above 120,000 pounds, a total gear reduction at or above 57, and a frame Resisting Bending Moment at or above 2,000,000 in-lbs per rail, or per rail and liner combination. Total gear reduction is the transmission gear ratio in the lowest gear multiplied by the drive axle ratio. A heavy-haul tractor is not a vocational tractor.

Hybrid engine or *hybrid powertrain* means an engine or powertrain that includes energy storage features other than a conventional battery system or conventional flywheel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems. Note that certain provisions in this part treat hybrid engines and powertrains intended for vehicles that include regenerative braking different than those intended for vehicles that do not include regenerative braking.

Hybrid vehicle means a vehicle that includes energy storage features (other than a conventional battery system or conventional flywheel) in addition to an internal combustion engine or other engine using consumable chemical fuel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems Note that certain provisions in this part treat hybrid vehicles that include regenerative braking different than those that do not include regenerative braking.

Hydrocarbon (HC) means the hydrocarbon group on which the emission standards are based for each fuel type. For alcohol-fueled vehicles, HC means nonmethane hydrocarbon equivalent (NMHCE) for exhaust emissions and total hydrocarbon equivalent (THCE) for evaporative emissions. For all other vehicles, HC means nonmethane hydrocarbon (NMHC) for exhaust emissions and total hydrocarbon (THC) for evaporative emissions.

Identification number means a unique specification (for example, a model number/serial number combination) that allows someone to distinguish a particular vehicle from other similar vehicles.

Incomplete vehicle has the meaning given in the definition of *vehicle* in this section.

Innovative technology means technology certified under § 1037.610.

Light-duty truck means any motor vehicle rated at or below 8,500 pounds GVWR with a curb weight at or below 6,000 pounds and basic vehicle frontal area at or below 45 square feet, which is:

(1) Designed primarily for purposes of transportation of property or is a derivation of such a vehicle; or

(2) Designed primarily for transportation of persons and has a capacity of more than 12 persons; or

(3) Available with special features enabling off-street or off-highway operation and use.

Light-duty vehicle means a passenger car or passenger car derivative capable of seating 12 or fewer passengers.

Low-mileage means relating to a vehicle with stabilized emissions and represents the undeteriorated emission level. This would generally involve approximately 4000 miles of operation.

Low rolling resistance tire means a tire on a vocational vehicle with a TRRL at or below of 7.7 kg/metric ton, a steer tire on a tractor with a TRRL at or below 7.7 kg/metric ton, or a drive tire on a tractor with a TRRL at or below 8.1 kg/metric ton.

Manufacture means the physical and engineering process of designing, constructing, and/or assembling a vehicle.

Manufacturer has the meaning given in section 216(1) of the Act. In general, this term includes any person who manufactures or assembles a vehicle for sale in the United States or otherwise introduces a new motor vehicle into commerce in the United States. This includes importers who import vehicles or vehicles for resale and entities that assemble glider kits.

Medium-duty passenger vehicle (MDPV) has the meaning given in 40 CFR 86.1803.

Model year means the manufacturer's annual new model production period, except as restricted under this definition and 40 CFR part 85, subpart X. It must include January 1 of the calendar year for which the model year is named, may not begin before January 2 of the previous calendar year, and it must end by December 31 of the named calendar year.

(1) The manufacturer who holds the certificate of conformity for the vehicle must assign the model year based on the date when its manufacturing operations are completed relative to its annual model year period. In unusual circumstances where completion of your assembly is delayed, we may allow you to assign a model year one year earlier, provided it does not affect which regulatory requirements will apply.

(2) Unless a vehicle is being shipped to a secondary manufacturer that will hold the certificate of conformity, the model year must be assigned prior to introduction of the vehicle into U.S. commerce. The certifying manufacturer must redesignate the model year if it does not complete its manufacturing operations within the originally identified model year. A vehicle introduced into U.S. commerce without a model year is deemed to have a model year equal to the calendar year of its introduction into U.S. commerce unless the certifying manufacturer assigns a later date.

Motor vehicle has the meaning given in 40 CFR 85.1703.

Multi-Purpose Duty Cycle has the meaning given in § 1037.510.

New motor vehicle has the meaning given in the Act. It generally means a motor vehicle meeting the criteria of either paragraph (1) or (2) of this definition. *New motor vehicles* may be complete or incomplete.

(1) A motor vehicle for which the ultimate purchaser has never received the equitable or legal title is a *new motor vehicle.* This kind of vehicle might commonly be thought of as ''brand new'' although a *new motor vehicle* may include previously used parts. For example, vehicles commonly known as ''glider kits'' or ''gliders'' are new motor vehicles. Under this definition, the vehicle is new from the time it is produced until the ultimate purchaser receives the title or places it into service, whichever comes first.

(2) An imported heavy-duty motor vehicle originally produced after the 1969 model year is a *new motor vehicle.*

Noncompliant vehicle means a vehicle that was originally covered by a certificate of conformity, but is not in the certified configuration or otherwise does not comply with the conditions of the certificate.

Nonconforming vehicle means a vehicle not covered by a certificate of conformity that would otherwise be subject to emission standards.

Nonmethane hydrocarbon (NMHC) means the sum of all hydrocarbon species except methane, as measured according to 40 CFR part 1065.

Nonmethane hydrocarbon equivalent has the meaning given in 40 CFR 1065.1001.

Off-cycle technology means technology certified under § 1037.610.

Official emission result means the measured emission rate for an emission-data vehicle on a given duty cycle before the application of any required deterioration factor, but after the applicability of regeneration adjustment factors.

Owners manual means a document or collection of documents prepared by the vehicle manufacturer for the owners or operators to describe appropriate vehicle maintenance, applicable warranties, and any other information related to operating or keeping the vehicle. The owners manual is typically provided to the ultimate purchaser at the time of sale.

Oxides of nitrogen has the meaning given in 40 CFR 1065.1001.

Particulate trap means a filtering device that is designed to physically trap all particulate matter above a certain size.

Percent has the meaning given in 40 CFR 1065.1001. Note that this means percentages identified in this part are assumed to be infinitely precise without regard to the number of significant figures. For example, one percent of 1,493 is 14.93.

Phase 1 means relating to the Phase 1 standards specified in §§ 1037.105 and 1037.106. Note that there are no Phase 1 standards for trailers. For example, a vehicle subject to the Phase 1 standards is a Phase 1 vehicle.

Phase 2 means relating to the Phase 2 standards specified in §§ 1037.105 through 1037.107.

Placed into service means put into initial use for its intended purpose, excluding incidental use by the manufacturer or a dealer.

Power take-off (PTO) means a secondary engine shaft (or equivalent) that provides substantial auxiliary power for purposes unrelated to vehicle propulsion or normal vehicle accessories such as air conditioning, power steering, and basic electrical accessories. A typical PTO uses a secondary shaft on the engine to transmit power to a hydraulic pump that powers auxiliary equipment, such as a boom on a bucket truck. You may ask us to consider other equivalent auxiliary power configurations (such as those with hybrid vehicles) as power take-off systems.

Preliminary approval means approval granted by an authorized EPA representative prior to submission of an application for certification, consistent with the provisions of § 1037.210.

Rechargeable Energy Storage System (RESS) means the component(s) of a hybrid engine or vehicle that store recovered energy for later use, such as the battery system in an electric hybrid vehicle.

Regional Duty Cycle has the meaning given in § 1037.510.

Regulatory subcategory has the meaning given in § 1037.230.

Relating to as used in this section means relating to something in a specific, direct manner. This expression is used in this section only to define terms as adjectives and not to broaden the meaning of the terms.

Revoke has the meaning given in 40 CFR 1068.30.

Roof height means the maximum height of a vehicle (rounded to the nearest inch), excluding narrow accessories such as exhaust pipes and antennas, but including any wide accessories such as roof fairings. Measure roof height of the vehicle configured to have its maximum height that will occur during actual use, with properly inflated tires and no driver, passengers, or cargo onboard. *Roof height* may also refer to the following categories:

(1) Low-roof means relating to a vehicle with a roof height of 120 inches or less.

(2) Mid-roof means relating to a vehicle with a roof height of 121 to 147 inches.

(3) High-roof means relating to a vehicle with a roof height of 148 inches or more.

Round has the meaning given in 40 CFR 1065.1001.

Scheduled maintenance means adjusting, repairing, removing, disassembling, cleaning, or replacing components or systems periodically to keep a part or system from failing, malfunctioning, or wearing prematurely. It also may mean actions you expect are necessary to correct an overt indication of failure or malfunction for which periodic maintenance is not appropriate.

Secondary vehicle manufacturer anyone that produces a vehicle by modifying a complete or partially complete vehicle. For the purpose of this definition, ''modifying'' does not include making changes that do not remove a vehicle from its original certified configuration. This definition applies whether the production involves a complete or partially complete vehicle and whether the vehicle was previously certified to emission standards or not. Manufacturers controlled by the manufacturer of the base vehicle (or by an entity that also controls the manufacturer of the base vehicle) are not secondary vehicle manufacturers; rather, both entities are considered to be one manufacturer for purposes of this part.

Sleeper cab means a type of tractor cab that has a compartment behind the driver's seat intended to be used by the driver for sleeping, and is not a heavy-haul tractor cab. This includes cabs accessible from the driver's compartment and those accessible from outside the vehicle.

Small manufacturer means a manufacturer meeting the criteria specified in 13 CFR 121.201. The employee and revenue limits apply to the total number employees and total revenue together for affiliated companies.

Spark-ignition has the meaning given in § 1037.101.

Standard payload means the payload assumed for each vehicle, in tons, for modeling and calculating emission credits, as follows:

(1) For vocational vehicles:

(i) 2.85 tons for light heavy-duty vehicles.

(ii) 5.6 tons for medium heavy-duty vehicles.

(iii) 7.5 tons for heavy heavy-duty vehicles.

(2) For tractors:

(i) 12.5 tons for Class 7.

(ii) 19 tons for Class 8, other than heavy-haul tractors.

(iii) 43 tons for heavy-haul tractors.

(3) For trailers:

(i) 10 tons for short box vans.

(ii) 19 tons for other trailers.

Standard tractor has the meaning given in § 1037.501.

Standard trailer has the meaning given in § 1037.501.

Suspend has the meaning given in 40 CFR 1068.30.

Test sample means the collection of vehicles or components selected from the population of a vehicle family for emission testing. This may include testing for certification, production-line testing, or in-use testing.

Test vehicle means a vehicle in a test sample.

Test weight means the vehicle weight used or represented during testing.

Tire rolling resistance level (TRRL) means a value with units of kg/metric ton that represents the rolling resistance of a tire configuration. TRRLs are used as modeling inputs under §§ 1037.515 and 1037.520. Note that a manufacturer may use the measured value for a tire configuration's coefficient of rolling resistance, or assign some higher value.

Total hydrocarbon has the meaning given in 40 CFR 1065.1001. This generally means the combined mass of organic compounds measured by the specified procedure for measuring total hydrocarbon, expressed as a hydrocarbon with an atomic hydrogen-to-carbon ratio of 1.85:1.

Total hydrocarbon equivalent has the meaning given in 40 CFR 1065.1001.

This generally means the sum of the carbon mass contributions of non-oxygenated hydrocarbons, alcohols and aldehydes, or other organic compounds that are measured separately as contained in a gas sample, expressed as exhaust hydrocarbon from petroleum-fueled vehicles. The atomic hydrogen-to-carbon ratio of the equivalent hydrocarbon is 1.85:1.

Tractor has the meaning given for ''truck tractor'' in 49 CFR 571.3. This includes most heavy-duty vehicles specifically designed for the primary purpose of pulling trailers, but does not include vehicles designed to carry other loads. For purposes of this definition ''other loads'' would not include loads carried in the cab, sleeper compartment, or toolboxes. Examples of vehicles that are similar to tractors but that are not *tractors* under this part include dromedary tractors, automobile haulers, straight trucks with trailers hitches, and tow trucks. Note that the provisions of this part that apply for tractors do not apply for tractors that are classified as vocational tractors under § 1037.630.

Trailer means a piece of equipment designed for carrying cargo and for being drawn by a tractor when coupled to the tractor's fifth wheel. Trailers may be divided into different types and categories as described in paragraphs (1) through (4) of this definition. The types of equipment identified in paragraph (5) of this definition are not trailers for purposes of this part.

(1) Box vans are trailers with an enclosed cargo space that is permanently attached to the chassis, with fixed sides, nose, and roof and is designed to carry a wide range of freight. Tankers are not box vans.

(2) Box vans with front-mounted, self-contained HVAC systems are refrigerated vans. Note that this includes systems that provide cooling, heating, or both. All other box vans are dry vans.

(3) Trailers that are not box vans are non-box trailers. This includes chassis that are designed only for temporarily mounted containers.

(4) Box trailers with length greater than 50 feet are long box trailers. Other box trailers are short box trailers.

(5) The following types of equipment are not trailers:

(i) Containers that are not permanently mounted on chassis.

(ii) [Reserved]

Urban Duty Cycle has the meaning given in § 1037.510.

Ultimate purchaser means, with respect to any new vehicle, the first person who in good faith purchases such new vehicle for purposes other than resale.

United States has the meaning given in 40 CFR 1068.30.

Upcoming model year means for a vehicle family the model year after the one currently in production.

U.S.-directed production volume means the number of vehicle units, subject to the requirements of this part, produced by a manufacturer for which the manufacturer has a reasonable assurance that sale was or will be made to ultimate purchasers in the United States. This does not include vehicles certified to state emission standards that are different than the emission standards in this part.

Useful life means the period during which a vehicle is required to comply with all applicable emission standards.

Vehicle means equipment intended for use on highways that meets at least one of the criteria of paragraph (1) of this definition, as follows:

(1) The following equipment are vehicles:

(i) A piece of equipment that is intended for self-propelled use on highways becomes a vehicle when it includes at least an engine, a transmission, and a frame. (**Note:** For purposes of this definition, any electrical, mechanical, and/or hydraulic devices attached to engines for the purpose of powering wheels are considered to be transmissions.)

(ii) A piece of equipment that is intended for self-propelled use on highways becomes a vehicle when it includes a passenger compartment attached to a frame with axles.

(iii) Trailers. A trailer becomes a vehicle when it has a frame with axles attached.

(2) Vehicles other than trailers may be complete or incomplete vehicles as follows:

(i) A *complete vehicle* is a functioning vehicle that has the primary load carrying device or container (or equivalent equipment) attached. Examples of equivalent equipment would include fifth wheel trailer hitches, firefighting equipment, and utility booms.

(ii) An *incomplete vehicle* is a vehicle that is not a complete vehicle. Incomplete vehicles may also be cab-complete vehicles. This may include vehicles sold to secondary vehicle manufacturers.

(iii) The primary use of the terms ''complete vehicle'' and ''incomplete vehicle'' are to distinguish whether a vehicle is complete when it is first sold as a vehicle.

(iv) You may ask us to allow you to certify a vehicle as incomplete if you manufacture the engines and sell the unassembled chassis components, as long as you do not produce and sell the body components necessary to complete the vehicle.

Vehicle configuration means a unique combination of vehicle hardware and calibration (related to measured or modeled emissions) within a vehicle family. Vehicles with hardware or software differences, but that have no hardware or software differences related to measured or modeled emissions may be included in the same vehicle configuration. Note that vehicles with hardware or software differences related to measured or modeled emissions are considered to be different configurations even if they have the same GEM inputs and FEL. Vehicles within a vehicle configuration differ only with respect to normal production variability or factors unrelated to measured or modeled emissions.

Vehicle family has the meaning given in § 1037.230.

Vehicle service class means a vehicle's weight class as specified in this definition. Note that, while *vehicle service class* is similar to primary intended service class for engines, they are not necessarily the same. For example, a medium heavy-duty vehicle may include a light heavy-duty engine.

(1) Light heavy-duty vehicles are those vehicles with GVWR below 19,500 pounds. Vehicles In this class include heavy-duty pickup trucks and vans, motor homes and other recreational vehicles, and some straight trucks with a single rear axle. Typical applications would include personal transportation, light-load commercial delivery, passenger service, agriculture, and construction.

(2) Medium heavy-duty vehicles are those vehicles with GVWR from 19,500 to 33,000 pounds. Vehicles in this class include school buses, straight trucks with a single rear axle, city tractors, and a variety of special purpose vehicles such as small dump trucks, and refuse trucks. Typical applications would include commercial short haul and intra-city delivery and pickup.

(3) Heavy heavy-duty vehicles are those vehicles with GVWR above 33,000 pounds. Vehicles in this class include tractors, urban buses, and other heavy trucks.

Vehicle subfamily or *subfamily* means a subset of a vehicle family including vehicles subject to the same FEL(s).

Vocational tractor means a vehicle classified as a vocational tractor under § 1037.630.

Vocational vehicle means relating to a vehicle subject to the standards of § 1037.105 (including vocational tractors).

Void has the meaning given in 40 CFR 1068.30.

Volatile liquid fuel means any fuel other than diesel or biodiesel that is a liquid at atmospheric pressure and has a Reid Vapor Pressure higher than 2.0 pounds per square inch.

We (us, our) means the Administrator of the Environmental Protection Agency and any authorized representatives.

§ 1037.805 Symbols, abbreviations, and acronyms.

The procedures in this part generally follow either the International System of Units (SI) or the United States customary units, as detailed in NIST Special Publication 811, which we incorporate by reference in § 1037.810. See 40 CFR 1065.20 for specific provisions related to these conventions. This section summarizes the way we use symbols, units of measure, and other abbreviations.

(a) *Symbols for chemical species.* This part uses the following symbols for chemical species and exhaust constituents:

Symbol	Species
C	carbon.
CH_4	methane.
CO	carbon monoxide.
CO_2	carbon dioxide.
H_2O	water.
HC	hydrocarbon.
NMHC	nonmethane hydrocarbon.
NMHCE	nonmethane hydrocarbon equivalent.
NO	nitric oxide.
NO_2	nitrogen dioxide.
NO_X	oxides of nitrogen.
N_2O	nitrous oxide.
PM	particulate matter.
THC	total hydrocarbon.
THCE	total hydrocarbon equivalent.

(b) *Symbols for quantities.* This part uses the following symbols and units of measure for various quantities:

Symbol	Quantity	Unit	Unit symbol	Unit in terms of SI base units
α	atomic hydrogen-to-carbon ratio.	mole per mole	mol/mol	1
α_0	intercept of air speed correction.			
α_1	slope of air speed correction.			
A	vehicle frictional load	pound force or newton	lbf or N	$kg{\cdot}m{\cdot}s^{-2}$
a_g	acceleration of Earth's gravity.	meters per second squared.	m/s^2	$m{\cdot}s^{-2}$
a_0	intercept of least squares regression.			
a_1	slope of least squares regression.			
B	vehicle load from drag and rolling resistance.	pound force per mile per hour or newton second per meter.	lbf/mph^2 or $N{\cdot}s^2/m^2$	$kg{\cdot}s^{-1}$
β	atomic oxygen-to-carbon ratio.	mole per mole	mol/mol	1
β_0	intercept of air direction correction.			
β_1	slope of air direction correction.			
C	vehicle-specific aerodynamic effects.	pound force per mile per hour squared or newton-second squared per meter squared.	lbf/mph^2 or $N{\cdot}s^2/m^2$	$kg{\cdot}m^{-1}$
C_i	constant.			
C_{DA}	drag area	meter squared	m^2	m^2
C_D	drag coefficient.			
CF	correction factor.			
C_{rr}	coefficient of rolling resistance.	kilogram per metric ton	kg/tonne	10^{-3}
D	distance	miles or meters	mi or m	m
e	mass-weighted emission result.	grams/ton-mile	g/ton-mi	g/kg-km
Eff	efficiency.			
F	adjustment factor.			
F	force	pound force or newton	lbf or N	$kg{\cdot}m{\cdot}s^{-2}$
f_n	angular speed (shaft)	revolutions per minute	r/min	$\pi{\cdot}30{\cdot}s^{-1}$
G	road grade	percent	%	10^{-2}
g	gravitational acceleration.	meters per second squared.	m/s^2	$m{\cdot}s^{-2}$
h	elevation or height	meters	m	m
i	indexing variable.			
k_a	drive axle ratio.			
k_d	transmission gear ratio.			
$k_{topgear}$	highest available transmission gear.			
m	mass	pound mass or kilogram	lbm or kg	kg
M	molar mass	gram per mole	g/mol	$10^{-3}{\cdot}kg{\cdot}mol^{-1}$
M	vehicle mass	kilogram	kg	kg
M_e	vehicle effective mass	kilogram	kg	kg

Symbol	Quantity	Unit	Unit symbol	Unit in terms of SI base units
$M_{rotating}$	inertial mass of rotating components.	kilogram	kg	kg
N	total number in series.			
$\dot{n}$	amount of substance rate.	mole per second	mol/s	$mol \cdot s^{-1}$
p	pressure	pascal	Pa	$kg \cdot m^{-1} \cdot s^{-2}$
ρ	mass density	kilogram per cubic meter.	kg/m^3	$kg \cdot m^{-3}$
PL	payload	tons	ton	kg
r	tire radius	meter	m	m
r^2	coefficient of determination.			
Re#	Reynolds number.			
SEE	standard estimate of error.			
TRRL	tire rolling resistance level.	kilogram per metric ton	kg/tonne	10^{-3}
θ	wind direction	degrees	°	°
T	absolute temperature	kelvin	K	K
T	Celsius temperature	degree Celsius	°C	K—273.15
T	torque (moment of force).	newton meter	N·m	$m^2 \cdot kg \cdot s^{-2}$
t	time	second	s	s
Δt	time interval, period, 1/frequency.	second	s	s
v	speed	miles per hour or meters per second.	mph or m/s	$m \cdot s^{-1}$
w	weighting factor.			
w	wind speed	miles per hour	mph	$m \cdot s^{-1}$
W	work	kilowatt-hour	kW·hr	$3.6 \cdot m^2 \cdot kg \cdot s^{-1}$
w_C	carbon mass fraction	gram/gram	g/g	1
WR	weight reduction	pound mass	lbm	kg
x	amount of substance mole fraction.	mole per mole	mol/mol	1

(c) *Superscripts.* This part uses the following superscripts to define a quantity:

Superscript	Quantity
overbar (such as $\bar{y}$)	arithmetic mean.
overdot (such as $\dot{y}$)	quantity per unit time.

(d) *Subscripts.* This part uses the following subscripts to define a quantity:

Subscript	Quantity
±6	6° yaw angle sweep.
aero	aerodynamic.
air	air.
alt.	alternative.
act	actual or measured condition.
air	air.
axle	axle.
brake	brake.
Ccombdry	carbon from fuel per mole of dry exhaust.
circuit	circuit.
coastdown	coastdown.
CO2PTO	CO_2 emissions for PTO cycle.
CO2urea	CO_2 from urea decomposition.
comp	composite.
cycle	test cycle.
driver	driver.
dyno	dynamometer.
event	event.
end	end.
fuel	fuel.
full	full.
grade	grade.
H2Oexhaustdry	H_2O in exhaust per mole of exhaust.
hi	high.
in	inlet.
idle	idle.
lo	low.
max	maximum.
meas	measured quantity.
min	minimum.
moving	moving.
out	outlet.
powertrain	powertrain.
record	record.
ref	reference quantity.
speed	speed.
start	start.
th	theoretical.
total	total.
trac	traction.
transient	transient.
urea	urea.
veh	vehicle.
w	wind.
wa	wind average.
yaw	yaw angle.
ys	yaw sweep.
zero	zero quantity.

(e) *Other acronyms and abbreviations.* This part uses the following additional abbreviations and acronyms:

ABT averaging, banking, and trading
AECD auxiliary emission control device
AES automatic engine shutdown
CFD computational fluid dynamics
CFR Code of Federal Regulations
CITT curb idle transmission torque
DOT Department of Transportation
EPA Environmental Protection Agency
FE fuel economy
FEL Family Emission Limit
GAWR gross axle weight rating
GCWR gross combination weight rating
GEM greenhouse gas emission model
GVWR gross vehicle weight rating
HVAC heating, ventilating, and air conditioning
ISO International Organization for Standardization
NARA National Archives and Records Administration
NHTSA National Highway Transportation Safety Administration
PTO power take-off
RESS rechargeable energy storage system
rpm revolutions per minute
SAE Society of Automotive Engineers
SKU stock-keeping unit
TRRL tire rolling resistance level

U.S.C United States Code
VSL vehicle speed limiter

(f) *Constants.* This part uses the following constants:

Symbol	Quantity	Value
g	gravitational constant.	9.81 m·s $^{-2}$
R	specific gas constant.	287.058 J/(kg·K)

(g) *Prefixes.* This part uses the following prefixes to define a quantity:

Symbol	Quantity	Value
μ	micro	10^{-6}
m	milli	10^{-3}
c	centi	10^{-2}
k	kilo	10^{3}
M	mega	10^{6}

§ 1037.810 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Environmental Protection Agency must publish a notice of the change in the **Federal Register** and the material must be available to the public. All approved material is available for inspection at U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave. NW., Room B102, EPA West Building, Washington, DC 20460, (202) 202–1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.*

(b) International Organization for Standardization, Case Postale 56, CH–1211 Geneva 20, Switzerland, (41) 22749 0111, *www.iso.org*, or *central@iso.org.*

(1) ISO 28580:2009(E) ''Passenger car, truck and bus tyres—Methods of measuring rolling resistance—Single point test and correlation of measurement results'', First Edition, July 1, 2009, (''ISO 28580''), IBR approved for § 1037.520(c).

(2) [Reserved]

(c) U.S. EPA, Office of Air and Radiation, 2565 Plymouth Road, Ann Arbor, MI 48105, *www.epa.gov.*

(1) Greenhouse gas Emissions Model (GEM) simulation tool, Version 2.0.1, September 2012 (''GEM version 2.0.1''), IBR approved for § 1037.520. The computer code for this model is available as noted in paragraph (a) of this section. A working version of this software is also available for download at *http://www.epa.gov/otaq/climate/gem.htm.*

(2) Greenhouse gas Emissions Model (GEM) Phase 2 simulation tool, Version 1.0, June 2015 (''GEM Phase 2 version 1.0'', or ''GEM_P2v1.0''); IBR approved for § 1037.520. The computer code for this model is available as noted in paragraph (a) of this section. A working version of this software is also available for download at *http://www.epa.gov/otaq/climate/gem.htm.*

(d) SAE International, 400 Commonwealth Dr., Warrendale, PA 15096–0001, (877) 606–7323 (U.S. and Canada) or (724) 776–4970 (outside the U.S. and Canada), *http://www.sae.org.*

(1) SAE J1252, SAE Wind Tunnel Test Procedure for Trucks and Buses, Revised July 2012, (''SAE J1252''), IBR approved for §§ 1037.525(d), 1037.529(a), and 1037.531(a).

(2) SAE J1263, Road Load Measurement and Dynamometer Simulation Using Coastdown Techniques, revised March 2010, (''SAE J1263''), IBR approved for §§ 1037.527 and 1037.665(a).

(3) SAE J1594, Vehicle Aerodynamics Terminology, Revised July 2010, (''SAE J1594''), IBR approved for § 1037.529(d).

(4) SAE J2071, Aerodynamic Testing of Road Vehicles—Open Throat Wind Tunnel Adjustment, Revised June 1994, (''SAE J2071''), IBR approved for § 1037.529(b).

(5) SAE J2263, Road Load Measurement Using Onboard Anemometry and Coastdown Techniques, revised December 2008, (''SAE J2263''), IBR approved for §§ 1037.527 and 1037.665(a).

(6) SAE J2343, Recommended Practice for LNG Medium and Heavy-Duty Powered Vehicles, Revised July 2008, (''SAE J2343''), IBR approved for § 1037.103(e).

(e) BASF Corporation, 100 Park Avenue, Florham Park, NJ 07932, (973) 245–6000, *http://www.basf.com.*

(1) BASF TI/EVO 0137 e, Emgard® FE 75W–90 Fuel Efficient Synthetic Gear Lubricant, April 2012, IBR approved for § 1037.560(a).

(2) [Reserved]

(f) National Institute of Standards and Technology, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899–1070, (301) 975–6478, or *www.nist.gov.*

(1) NIST Special Publication 811, 2008 Edition, Guide for the Use of the International System of Units (SI), March 2008, IBR approved for § 1037.805.

(2) [Reserved]

§ 1037.815 Confidential information.

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

§ 1037.820 Requesting a hearing.

(a) You may request a hearing under certain circumstances, as described elsewhere in this part. To do this, you must file a written request, including a description of your objection and any supporting data, within 30 days after we make a decision.

(b) For a hearing you request under the provisions of this part, we will approve your request if we find that your request raises a substantial factual issue.

(c) If we agree to hold a hearing, we will use the procedures specified in 40 CFR part 1068, subpart G.

§ 1037.825 Reporting and recordkeeping requirements.

(a) This part includes various requirements to submit and record data or other information. Unless we specify otherwise, store required records in any format and on any media and keep them readily available for eight years after you send an associated application for certification, or eight years after you generate the data if they do not support an application for certification. You may not rely on anyone else to meet recordkeeping requirements on your behalf unless we specifically authorize it. We may review these records at any time. You must promptly send us organized, written records in English if we ask for them. We may require you to submit written records in an electronic format.

(b) The regulations in § 1037.255 and 40 CFR 1068.25 and 1068.101 describe your obligation to report truthful and complete information. This includes information not related to certification. Failing to properly report information and keep the records we specify violates 40 CFR 1068.101(a)(2), which may involve civil or criminal penalties.

(c) Send all reports and requests for approval to the Designated Compliance Officer (see § 1037.801).

(d) Any written information we require you to send to or receive from another company is deemed to be a required record under this section. Such records are also deemed to be submissions to EPA. Keep these records for eight years unless the regulations specify a different period. We may require you to send us these records whether or not you are a certificate holder.

(e) Under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*), the Office of Management and Budget approves the reporting and recordkeeping specified in the applicable regulations. The following items illustrate the kind of reporting and recordkeeping we require for vehicles regulated under this part:

(1) We specify the following requirements related to vehicle certification in this part 1037:

(i) In subpart C of this part we identify a wide range of information required to certify vehicles.

(ii) In subpart G of this part we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various special compliance provisions.

(iii) In § 1037.725, 1037.730, and 1037.735 we specify certain records related to averaging, banking, and trading.

(2) We specify the following requirements related to testing in 40 CFR part 1066:

(i) In 40 CFR 1066.2 we give an overview of principles for reporting information.

(ii) In 40 CFR 1066.25 we establish basic guidelines for storing test information.

(iii) In 40 CFR 1066.695 we identify the specific information and data items to record when measuring emissions.

(3) We specify the following requirements related to the general compliance provisions in 40 CFR part 1068:

(i) In 40 CFR 1068.5 we establish a process for evaluating good engineering judgment related to testing and certification.

(ii) In 40 CFR 1068.25 we describe general provisions related to sending and keeping information.

(iii) In 40 CFR 1068.27 we require manufacturers to make engines available for our testing or inspection if we make such a request.

(iv) In 40 CFR 1068.105 we require vehicle manufacturers to keep certain records related to duplicate labels from engine manufacturers.

(v) In 40 CFR 1068.120 we specify recordkeeping related to rebuilding engines.

(vi) In 40 CFR part 1068, subpart C, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various exemptions.

(vii) In 40 CFR part 1068, subpart D, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to importing engines.

(viii) In 40 CFR 1068.450 and 1068.455 we specify certain records related to testing production-line engines in a selective enforcement audit.

(ix) In 40 CFR 1068.501 we specify certain records related to investigating and reporting emission-related defects.

(x) In 40 CFR 1068.525 and 1068.530 we specify certain records related to recalling nonconforming engines.

Appendix I to Part 1037—Heavy-Duty Transient Test Cycle

Time (sec)	Speed (mph)	Speed (m/s)
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.00	0.00
5	0.00	0.00
6	0.00	0.00
7	0.41	0.18
8	1.18	0.53
9	2.26	1.01
10	3.19	1.43
11	3.97	1.77
12	4.66	2.08
13	5.32	2.38
14	5.94	2.66
15	6.48	2.90
16	6.91	3.09
17	7.28	3.25
18	7.64	3.42
19	8.02	3.59
20	8.36	3.74
21	8.60	3.84
22	8.74	3.91
23	8.82	3.94
24	8.82	3.94
25	8.76	3.92
26	8.66	3.87
27	8.58	3.84
28	8.52	3.81
29	8.46	3.78
30	8.38	3.75
31	8.31	3.71
32	8.21	3.67
33	8.11	3.63
34	8.00	3.58
35	7.94	3.55
36	7.94	3.55
37	7.80	3.49
38	7.43	3.32
39	6.79	3.04
40	5.81	2.60
41	4.65	2.08
42	3.03	1.35
43	1.88	0.84
44	1.15	0.51
45	1.14	0.51
46	1.12	0.50
47	1.11	0.50
48	1.19	0.53
49	1.57	0.70
50	2.31	1.03
51	3.37	1.51
52	4.51	2.02
53	5.56	2.49
54	6.41	2.87
55	7.09	3.17
56	7.59	3.39
57	7.99	3.57
58	8.32	3.72
59	8.64	3.86
60	8.91	3.98
61	9.13	4.08
62	9.29	4.15
63	9.40	4.20
64	9.39	4.20
65	9.20	4.11
66	8.84	3.95
67	8.35	3.73
68	7.81	3.49
69	7.22	3.23
70	6.65	2.97
71	6.13	2.74
72	5.75	2.57
73	5.61	2.51
74	5.65	2.53
75	5.80	2.59
76	5.95	2.66
77	6.09	2.72
78	6.21	2.78
79	6.31	2.82
80	6.34	2.83
81	6.47	2.89
82	6.65	2.97
83	6.88	3.08
84	7.04	3.15
85	7.05	3.15
86	7.01	3.13
87	6.90	3.08
88	6.88	3.08
89	6.89	3.08
90	6.96	3.11
91	7.04	3.15
92	7.17	3.21
93	7.29	3.26
94	7.39	3.30
95	7.48	3.34
96	7.57	3.38
97	7.61	3.40
98	7.59	3.39
99	7.53	3.37
100	7.46	3.33
101	7.40	3.31
102	7.39	3.30
103	7.38	3.30
104	7.37	3.29
105	7.37	3.29
106	7.39	3.30
107	7.42	3.32
108	7.43	3.32
109	7.40	3.31
110	7.39	3.30
111	7.42	3.32
112	7.50	3.35
113	7.57	3.38
114	7.60	3.40
115	7.60	3.40
116	7.61	3.40
117	7.64	3.42
118	7.68	3.43
119	7.74	3.46
120	7.82	3.50
121	7.90	3.53
122	7.96	3.56
123	7.99	3.57
124	8.02	3.59
125	8.01	3.58
126	7.87	3.52
127	7.59	3.39
128	7.20	3.22
129	6.52	2.91
130	5.53	2.47
131	4.36	1.95
132	3.30	1.48
133	2.50	1.12
134	1.94	0.87

Time (sec)	Speed (mph)	Speed (m/s)
135	1.56	0.70
136	0.95	0.42
137	0.42	0.19
138	0.00	0.00
139	0.00	0.00
140	0.00	0.00
141	0.00	0.00
142	0.00	0.00
143	0.00	0.00
144	0.00	0.00
145	0.00	0.00
146	0.00	0.00
147	0.00	0.00
148	0.00	0.00
149	0.00	0.00
150	0.00	0.00
151	0.00	0.00
152	0.00	0.00
153	0.00	0.00
154	0.00	0.00
155	0.00	0.00
156	0.00	0.00
157	0.00	0.00
158	0.00	0.00
159	0.00	0.00
160	0.00	0.00
161	0.00	0.00
162	0.00	0.00
163	0.00	0.00
164	0.00	0.00
165	0.00	0.00
166	0.00	0.00
167	0.00	0.00
168	0.00	0.00
169	0.00	0.00
170	0.00	0.00
171	0.00	0.00
172	1.11	0.50
173	2.65	1.18
174	4.45	1.99
175	5.68	2.54
176	6.75	3.02
177	7.59	3.39
178	7.75	3.46
179	7.63	3.41
180	7.67	3.43
181	8.70	3.89
182	10.20	4.56
183	11.92	5.33
184	12.84	5.74
185	13.27	5.93
186	13.38	5.98
187	13.61	6.08
188	14.15	6.33
189	14.84	6.63
190	16.49	7.37
191	18.33	8.19
192	20.36	9.10
193	21.47	9.60
194	22.35	9.99
195	22.96	10.26
196	23.46	10.49
197	23.92	10.69
198	24.42	10.92
199	24.99	11.17
200	25.91	11.58
201	26.26	11.74
202	26.38	11.79
203	26.26	11.74
204	26.49	11.84
205	26.76	11.96
206	27.07	12.10
207	26.64	11.91
208	25.99	11.62
209	24.77	11.07
210	24.04	10.75
211	23.39	10.46
212	22.73	10.16
213	22.16	9.91
214	21.66	9.68
215	21.39	9.56
216	21.43	9.58
217	20.67	9.24
218	17.98	8.04
219	13.15	5.88
220	7.71	3.45
221	3.30	1.48
222	0.88	0.39
223	0.00	0.00
224	0.00	0.00
225	0.00	0.00
226	0.00	0.00
227	0.00	0.00
228	0.00	0.00
229	0.00	0.00
230	0.00	0.00
231	0.00	0.00
232	0.00	0.00
233	0.00	0.00
234	0.00	0.00
235	0.00	0.00
236	0.00	0.00
237	0.00	0.00
238	0.00	0.00
239	0.00	0.00
240	0.00	0.00
241	0.00	0.00
242	0.00	0.00
243	0.00	0.00
244	0.00	0.00
245	0.00	0.00
246	0.00	0.00
247	0.00	0.00
248	0.00	0.00
249	0.00	0.00
250	0.00	0.00
251	0.00	0.00
252	0.00	0.00
253	0.00	0.00
254	0.00	0.00
255	0.00	0.00
256	0.00	0.00
257	0.00	0.00
258	0.00	0.00
259	0.50	0.22
260	1.57	0.70
261	3.07	1.37
262	4.57	2.04
263	5.65	2.53
264	6.95	3.11
265	8.05	3.60
266	9.13	4.08
267	10.05	4.49
268	11.62	5.19
269	12.92	5.78
270	13.84	6.19
271	14.38	6.43
272	15.64	6.99
273	17.14	7.66
274	18.21	8.14
275	18.90	8.45
276	19.44	8.69
277	20.09	8.98
278	21.89	9.79
279	24.15	10.80
280	26.26	11.74
281	26.95	12.05
282	27.03	12.08
283	27.30	12.20
284	28.10	12.56
285	29.44	13.16
286	30.78	13.76
287	32.09	14.35
288	33.24	14.86
289	34.46	15.40
290	35.42	15.83
291	35.88	16.04
292	36.03	16.11
293	35.84	16.02
294	35.65	15.94
295	35.31	15.78
296	35.19	15.73
297	35.12	15.70
298	35.12	15.70
299	35.04	15.66
300	35.08	15.68
301	35.04	15.66
302	35.34	15.80
303	35.50	15.87
304	35.77	15.99
305	35.81	16.01
306	35.92	16.06
307	36.23	16.20
308	36.42	16.28
309	36.65	16.38
310	36.26	16.21
311	36.07	16.12
312	35.84	16.02
313	35.96	16.08
314	36.00	16.09
315	35.57	15.90
316	35.00	15.65
317	34.08	15.24
318	33.39	14.93
319	32.20	14.39
320	30.32	13.55
321	28.48	12.73
322	26.95	12.05
323	26.18	11.70
324	25.38	11.35
325	24.77	11.07
326	23.46	10.49
327	22.39	10.01
328	20.97	9.37
329	20.09	8.98
330	18.90	8.45
331	18.17	8.12
332	16.48	7.37
333	15.07	6.74
334	12.23	5.47
335	10.08	4.51
336	7.71	3.45
337	7.32	3.27
338	8.63	3.86
339	10.77	4.81
340	12.65	5.66
341	13.88	6.20
342	15.03	6.72
343	15.64	6.99
344	16.99	7.60
345	17.98	8.04
346	19.13	8.55
347	18.67	8.35
348	18.25	8.16
349	18.17	8.12
350	18.40	8.23
351	19.63	8.78
352	20.32	9.08
353	21.43	9.58

Time (sec)	Speed (mph)	Speed (m/s)
354	21.47	9.60
355	21.97	9.82
356	22.27	9.96
357	22.69	10.14
358	23.15	10.35
359	23.69	10.59
360	23.96	10.71
361	24.27	10.85
362	24.34	10.88
363	24.50	10.95
364	24.42	10.92
365	24.38	10.90
366	24.31	10.87
367	24.23	10.83
368	24.69	11.04
369	25.11	11.23
370	25.53	11.41
371	25.38	11.35
372	24.58	10.99
373	23.77	10.63
374	23.54	10.52
375	23.50	10.51
376	24.15	10.80
377	24.30	10.86
378	24.15	10.80
379	23.19	10.37
380	22.50	10.06
381	21.93	9.80
382	21.85	9.77
383	21.55	9.63
384	21.89	9.79
385	21.97	9.82
386	21.97	9.82
387	22.01	9.84
388	21.85	9.77
389	21.62	9.67
390	21.62	9.67
391	22.01	9.84
392	22.81	10.20
393	23.54	10.52
394	24.38	10.90
395	24.80	11.09
396	24.61	11.00
397	23.12	10.34
398	21.62	9.67
399	19.90	8.90
400	18.86	8.43
401	17.79	7.95
402	17.25	7.71
403	16.91	7.56
404	16.75	7.49
405	16.75	7.49
406	16.87	7.54
407	16.37	7.32
408	16.37	7.32
409	16.49	7.37
410	17.21	7.69
411	17.41	7.78
412	17.37	7.77
413	16.87	7.54
414	16.72	7.47
415	16.22	7.25
416	15.76	7.05
417	14.72	6.58
418	13.69	6.12
419	12.00	5.36
420	10.43	4.66
421	8.71	3.89
422	7.44	3.33
423	5.71	2.55
424	4.22	1.89
425	2.30	1.03
426	1.00	0.45
427	0.00	0.00
428	0.61	0.27
429	1.19	0.53
430	1.61	0.72
431	1.53	0.68
432	2.34	1.05
433	4.29	1.92
434	7.25	3.24
435	10.20	4.56
436	12.46	5.57
437	14.53	6.50
438	16.22	7.25
439	17.87	7.99
440	19.74	8.82
441	21.01	9.39
442	22.23	9.94
443	22.62	10.11
444	23.61	10.55
445	24.88	11.12
446	26.15	11.69
447	26.99	12.07
448	27.56	12.32
449	28.18	12.60
450	28.94	12.94
451	29.83	13.34
452	30.78	13.76
453	31.82	14.22
454	32.78	14.65
455	33.24	14.86
456	33.47	14.96
457	33.31	14.89
458	33.08	14.79
459	32.78	14.65
460	32.39	14.48
461	32.13	14.36
462	31.82	14.22
463	31.55	14.10
464	31.25	13.97
465	30.94	13.83
466	30.71	13.73
467	30.56	13.66
468	30.79	13.76
469	31.13	13.92
470	31.55	14.10
471	31.51	14.09
472	31.47	14.07
473	31.44	14.05
474	31.51	14.09
475	31.59	14.12
476	31.67	14.16
477	32.01	14.31
478	32.63	14.59
479	33.39	14.93
480	34.31	15.34
481	34.81	15.56
482	34.20	15.29
483	32.39	14.48
484	30.29	13.54
485	28.56	12.77
486	26.45	11.82
487	24.79	11.08
488	23.12	10.34
489	20.73	9.27
490	18.33	8.19
491	15.72	7.03
492	13.11	5.86
493	10.47	4.68
494	7.82	3.50
495	5.70	2.55
496	3.57	1.60
497	0.92	0.41
498	0.00	0.00
499	0.00	0.00
500	0.00	0.00
501	0.00	0.00
502	0.00	0.00
503	0.00	0.00
504	0.00	0.00
505	0.00	0.00
506	0.00	0.00
507	0.00	0.00
508	0.00	0.00
509	0.00	0.00
510	0.00	0.00
511	0.00	0.00
512	0.00	0.00
513	0.00	0.00
514	0.00	0.00
515	0.00	0.00
516	0.00	0.00
517	0.00	0.00
518	0.00	0.00
519	0.00	0.00
520	0.00	0.00
521	0.00	0.00
522	0.50	0.22
523	1.50	0.67
524	3.00	1.34
525	4.50	2.01
526	5.80	2.59
527	6.52	2.91
528	6.75	3.02
529	6.44	2.88
530	6.17	2.76
531	6.33	2.83
532	6.71	3.00
533	7.40	3.31
534	7.67	3.43
535	7.33	3.28
536	6.71	3.00
537	6.41	2.87
538	6.60	2.95
539	6.56	2.93
540	5.94	2.66
541	5.45	2.44
542	5.87	2.62
543	6.71	3.00
544	7.56	3.38
545	7.59	3.39
546	7.63	3.41
547	7.67	3.43
548	7.67	3.43
549	7.48	3.34
550	7.29	3.26
551	7.29	3.26
552	7.40	3.31
553	7.48	3.34
554	7.52	3.36
555	7.52	3.36
556	7.48	3.34
557	7.44	3.33
558	7.28	3.25
559	7.21	3.22
560	7.09	3.17
561	7.06	3.16
562	7.29	3.26
563	7.75	3.46
564	8.55	3.82
565	9.09	4.06
566	10.04	4.49
567	11.12	4.97
568	12.46	5.57
569	13.00	5.81
570	14.26	6.37
571	15.37	6.87
572	17.02	7.61

Time (sec)	Speed (mph)	Speed (m/s)
573	18.17	8.12
574	19.21	8.59
575	20.17	9.02
576	20.66	9.24
577	21.12	9.44
578	21.43	9.58
579	22.66	10.13
580	23.92	10.69
581	25.42	11.36
582	25.53	11.41
583	26.68	11.93
584	28.14	12.58
585	30.06	13.44
586	30.94	13.83
587	31.63	14.14
588	32.36	14.47
589	33.24	14.86
590	33.66	15.05
591	34.12	15.25
592	35.92	16.06
593	37.72	16.86
594	39.26	17.55
595	39.45	17.64
596	39.83	17.81
597	40.18	17.96
598	40.48	18.10
599	40.75	18.22
600	41.02	18.34
601	41.36	18.49
602	41.79	18.68
603	42.40	18.95
604	42.82	19.14
605	43.05	19.25
606	43.09	19.26
607	43.24	19.33
608	43.59	19.49
609	44.01	19.67
610	44.35	19.83
611	44.55	19.92
612	44.82	20.04
613	45.05	20.14
614	45.31	20.26
615	45.58	20.38
616	46.00	20.56
617	46.31	20.70
618	46.54	20.81
619	46.61	20.84
620	46.92	20.98
621	47.19	21.10
622	47.46	21.22
623	47.54	21.25
624	47.54	21.25
625	47.54	21.25
626	47.50	21.23
627	47.50	21.23
628	47.50	21.23
629	47.31	21.15
630	47.04	21.03
631	46.77	20.91
632	45.54	20.36
633	43.24	19.33
634	41.52	18.56
635	39.79	17.79
636	38.07	17.02
637	36.34	16.25
638	34.04	15.22
639	32.45	14.51
640	30.86	13.80
641	28.83	12.89
642	26.45	11.82
643	24.27	10.85
644	22.04	9.85
645	19.82	8.86
646	17.04	7.62
647	14.26	6.37
648	11.52	5.15
649	8.78	3.93
650	7.17	3.21
651	5.56	2.49
652	3.72	1.66
653	3.38	1.51
654	3.11	1.39
655	2.58	1.15
656	1.66	0.74
657	0.67	0.30
658	0.00	0.00
659	0.00	0.00
660	0.00	0.00
661	0.00	0.00
662	0.00	0.00
663	0.00	0.00
664	0.00	0.00
665	0.00	0.00
666	0.00	0.00
667	0.00	0.00
668	0.00	0.00

Appendix II to Part 1037—Power Take-Off Test Cycle

Cycle simulation	Mode	Start time of mode	Normalized pressure, circuit 1 (%)	Normalized pressure, circuit 2 (%)
Utility	0	0	0.0	0.0
Utility	1	33	80.5	0.0
Utility	2	40	0.0	0.0
Utility	3	145	83.5	0.0
Utility	4	289	0.0	0.0
Refuse	5	361	0.0	13.0
Refuse	6	363	0.0	38.0
Refuse	7	373	0.0	53.0
Refuse	8	384	0.0	73.0
Refuse	9	388	0.0	0.0
Refuse	10	401	0.0	13.0
Refuse	11	403	0.0	38.0
Refuse	12	413	0.0	53.0
Refuse	13	424	0.0	73.0
Refuse	14	442	11.2	0.0
Refuse	15	468	29.3	0.0
Refuse	16	473	0.0	0.0
Refuse	17	486	11.2	0.0
Refuse	18	512	29.3	0.0
Refuse	19	517	0.0	0.0
Refuse	20	530	12.8	11.1
Refuse	21	532	12.8	38.2
Refuse	22	541	12.8	53.4
Refuse	23	550	12.8	73.5
Refuse	24	553	0.0	0.0
Refuse	25	566	12.8	11.1
Refuse	26	568	12.8	38.2
Refuse	27	577	12.8	53.4
Refuse	28	586	12.8	73.5
Refuse	29	589	0.0	0.0
Refuse	30	600	0.0	0.0

Appendix III to Part 1037—Emission Control Identifiers

This appendix identifies abbreviations for emission control information labels, as required under § 1037.135.

Vehicle Speed Limiters

—VSL—Vehicle speed limiter
—VSLS—''Soft-top'' vehicle speed limiter
—VSLE—Expiring vehicle speed limiter
—VSLD—Vehicle speed limiter with both ''soft-top'' and expiration

Idle Reduction Technology

—IRT5—Engine shutoff after 5 minutes or less of idling
—IRTE—Expiring engine shutoff

Tires

—LRRA—Low rolling resistance tires (all)
—LRRD—Low rolling resistance tires (drive)
—LRRS—Low rolling resistance tires (steer)

Aerodynamic Components

—ATS—Aerodynamic side skirt and/or fuel tank fairing
—ARF—Aerodynamic roof fairing
—ARFR—Adjustable height aerodynamic roof fairing
—TGR—Gap reducing tractor fairing (tractor to trailer gap)
—TGRT—Gap reducing trailer fairing (tractor to trailer gap)
—TATS—Trailer aerodynamic side skirt
—TARF—Trailer aerodynamic rear fairing
—TAUD—Trailer aerodynamic underbody device

Other Components

—ADVH—Vehicle includes advanced hybrid technology components
—ADVO—Vehicle includes other advanced technology components (*i.e.*, non-hybrid system)
—INV—Vehicle includes innovative (off-cycle) technology components
—ATI—Automatic tire inflation system
—WRTW—Weight-reducing trailer wheels
—WRTC—Weight-reducing trailer upper coupler plate
—WRTS—Weight-reducing trailer axle sub-frames
—WBSW—Wide-based single trailer tires with steel wheel
—WBAW—Wide-based single trailer tires with aluminum wheel
—WBLW—Wide-based single trailer tires with light-weight aluminum alloy wheel
—DWSW—Dual-wide trailer tires with steel wheel
—DWAW—Dual-wide trailer tires with aluminum wheel
—DWLW—Dual-wide trailer tires with light-weight aluminum alloy wheel

Appendix IV to Part 1037—Heavy-Duty Grade Profile for Phase 2 Steady-State Test Cycles

Distance (m)	Grade (%)
0	0
2	0
5	0
7	−0.01
10	−0.03
12	−0.04
15	−0.04
17	−0.07
20	−0.09
22	−0.1
25	−0.12
27	−0.12
29	−0.13
32	−0.15
145	−0.15
148	−0.16
256	−0.16
258	−0.17
263	−0.17
266	−0.18
273	−0.18
275	−0.19
354	−0.19
357	−0.18
374	−0.18
376	−0.17
391	−0.17
394	−0.16
455	−0.16
457	−0.15
470	−0.15
472	−0.14
602	−0.14
605	−0.15
720	−0.15
723	−0.14
770	−0.14
772	−0.15
782	−0.15
784	−0.16
794	−0.16
797	−0.17
807	−0.17
809	−0.18
917	−0.18
920	−0.17
922	−0.17
925	−0.16
927	−0.15
930	−0.15
932	−0.14
934	−0.14
937	−0.13
939	−0.12
942	−0.12
944	−0.11
947	−0.11
949	−0.1
952	−0.1
954	−0.09
957	−0.08
959	−0.08
962	−0.07
1038	−0.07
1040	0
1043	0.06
1045	0.13
1048	0.19
1050	0.26
1052	0.32
1055	0.38
1057	0.45
1060	0.51
1062	0.58
1111	0.58
1114	0.62
1116	0.67
1119	0.71
1121	0.71
1124	0.8
1126	0.85
1128	0.89
1131	0.94
1133	0.99
1136	1.03
1163	1.03
1165	1.17
1168	1.24
1170	1.24
1172	1.38
1175	1.45
1177	1.52
1180	1.59
1182	1.66
1185	1.73
1258	1.73
1260	1.74
1262	1.75
1265	1.76
1267	1.76
1270	1.77
1272	1.78
1275	1.79
1277	1.8
1279	1.81
1282	1.82
1357	1.82
1360	1.81
1364	1.81
1367	1.8
1372	1.8
1374	1.79
1377	1.79
1379	1.78
1384	1.78
1386	1.77
1394	1.77
1396	1.76
1401	1.76
1403	1.75
1486	1.75
1488	1.76
1561	1.76
1564	1.77
1598	1.77
1600	1.78
1695	1.78
1698	1.77
1703	1.77
1705	1.76
1710	1.76
1713	1.75
1717	1.75
1720	1.74
1725	1.74
1727	1.73
1735	1.73
1737	1.72
1742	1.72
1744	1.71
1769	1.71
1771	1.7
1774	1.69
1776	1.68
1778	1.67
1781	1.66
1783	1.65
1786	1.64
1788	1.63
1791	1.62
1793	1.61

Distance (m)	Grade (%)	Distance (m)	Grade (%)	Distance (m)	Grade (%)
1818	1.61	2360	−0.5	4023	−0.87
1820	1.58	2362	−0.49	4026	−0.89
1822	1.55	2367	−0.49	4028	−0.9
1825	1.52	2370	−0.48	4031	−0.92
1827	1.49	2377	−0.48	4033	−0.93
1830	1.46	2380	−0.47	4110	−0.93
1832	1.43	2436	−0.47	4112	−0.95
1835	1.41	2439	−0.46	4115	−0.99
1837	1.38	2483	−0.46	4117	−1
1840	1.35	2485	−0.45	4119	−1.02
1842	1.32	2508	−0.45	4122	−1.04
1940	1.32	2510	−0.44	4124	−1.06
1943	1.27	2530	−0.44	4127	−1.07
1945	1.21	2532	−0.43	4129	−1.09
1947	1.16	2672	−0.43	4132	−1.11
1950	1.11	2675	−0.44	4233	−1.11
1952	1.06	2694	−0.44	4236	−1.1
1955	1.01	2697	−0.45	4243	−1.1
1957	0.96	2717	−0.45	4246	−1.09
1960	0.91	2719	−0.46	4288	−1.09
1962	0.85	2817	−0.46	4290	−1.08
1965	0.8	2820	−0.47	4385	−1.08
1989	0.8	2881	−0.47	4387	−1.07
1992	0.77	2884	−0.46	4399	−1.07
1994	0.74	2899	−0.46	4402	−1.06
1997	0.71	2901	−0.45	4429	−1.06
1999	0.71	2916	−0.45	4432	−1.04
2002	0.65	2918	−0.44	4434	−1.03
2004	0.61	3034	−0.44	4437	−1.01
2006	0.58	3036	−0.43	4439	−0.99
2009	0.55	3157	−0.43	4442	−0.97
2011	0.52	3159	−0.42	4444	−0.97
2014	0.49	3233	−0.42	4447	−0.93
2016	0.44	3236	−0.43	4449	−0.91
2019	0.38	3398	−0.43	4452	−0.9
2021	0.33	3401	−0.42	4454	−0.88
2024	0.28	3570	−0.42	4553	−0.88
2026	0.23	3573	−0.43	4556	−0.83
2029	0.18	3580	−0.43	4558	−0.83
2031	0.12	3583	−0.44	4561	−0.74
2034	0.07	3588	−0.44	4563	−0.74
2036	0.02	3590	−0.45	4566	−0.64
2038	−0.03	3789	−0.45	4568	−0.59
2165	−0.03	3792	−0.44	4571	−0.55
2167	−0.09	3802	−0.44	4573	−0.5
2170	−0.12	3804	−0.43	4576	−0.45
2172	−0.15	3861	−0.43	4578	−0.41
2175	−0.18	3863	−0.45	4603	−0.41
2177	−0.2	3866	−0.47	4605	−0.39
2180	−0.23	3868	−0.49	4608	−0.37
2182	−0.26	3871	−0.51	4610	−0.35
2185	−0.26	3873	−0.53	4613	−0.33
2187	−0.32	3875	−0.55	4615	−0.32
2190	−0.33	3878	−0.57	4618	−0.3
2192	−0.34	3880	−0.59	4620	−0.28
2194	−0.36	3883	−0.59	4623	−0.26
2197	−0.37	3885	−0.63	4625	−0.24
2199	−0.38	3984	−0.63	4628	−0.23
2202	−0.39	3986	−0.65	4652	−0.23
2204	−0.41	3989	−0.66	4655	−0.2
2207	−0.42	3991	−0.68	4657	−0.2
2209	−0.43	3994	−0.69	4660	−0.16
2212	−0.45	3996	−0.71	4662	−0.14
2269	−0.45	3999	−0.72	4665	−0.11
2271	−0.46	4001	−0.74	4667	−0.09
2278	−0.46	4004	−0.75	4670	−0.07
2281	−0.47	4006	−0.75	4672	−0.05
2288	−0.47	4008	−0.78	4675	−0.02
2291	−0.48	4011	−0.8	4677	0
2298	−0.48	4013	−0.81	4751	0
2301	−0.49	4016	−0.83	4753	−0.01
2308	−0.49	4018	−0.84	4756	−0.01
2311	−0.5	4021	−0.84	4758	−0.02

Distance (m)	Grade (%)	Distance (m)	Grade (%)	Distance (m)	Grade (%)
4760	−0.02	5586	0.98	6429	0.97
4763	−0.03	5588	1	6431	0.94
4765	−0.03	5590	1.02	6434	0.91
4768	−0.04	5593	1.03	6436	0.87
4770	−0.04	5595	1.05	6439	0.84
4773	−0.05	5598	1.07	6441	0.84
4873	−0.05	5600	1.09	6443	0.77
4875	−0.06	5603	1.11	6517	0.77
4880	−0.06	5605	1.13	6520	0.73
4883	−0.07	5608	1.15	6522	0.7
4885	−0.07	5610	1.17	6525	0.66
4888	−0.08	5612	1.18	6527	0.62
4893	−0.08	5615	1.19	6529	0.58
4895	−0.09	5617	1.2	6532	0.55
4976	−0.09	5620	1.21	6534	0.51
4979	−0.08	5622	1.21	6537	0.47
4981	−0.08	5625	1.23	6539	0.43
4984	−0.07	5627	1.24	6542	0.4
4991	−0.07	5630	1.25	6566	0.4
4993	−0.06	5632	1.26	6569	0.34
5072	−0.06	5634	1.27	6571	0.29
5075	−0.05	5732	1.27	6574	0.24
5084	−0.05	5734	1.26	6576	0.19
5087	−0.04	5739	1.26	6579	0.14
5094	−0.04	5742	1.25	6581	0.08
5097	−0.03	5749	1.25	6584	0.03
5107	−0.03	5752	1.24	6586	−0.02
5109	−0.02	5759	1.24	6589	−0.07
5200	−0.02	5761	1.23	6591	−0.12
5202	−0.03	5769	1.23	6665	−0.12
5210	−0.03	5771	1.22	6668	−0.15
5212	−0.04	5776	1.22	6670	−0.17
5340	−0.04	5779	1.21	6673	−0.2
5343	−0.03	5810	1.21	6675	−0.22
5345	−0.03	5813	1.2	6678	−0.24
5347	−0.02	5825	1.2	6680	−0.27
5352	−0.02	5828	1.19	6683	−0.29
5355	−0.01	5977	1.19	6685	−0.31
5357	0	5980	1.2	6687	−0.31
5360	0	5997	1.2	6690	−0.36
5362	0.01	5999	1.21	6692	−0.36
5414	0.01	6102	1.21	6695	−0.44
5416	0.05	6105	1.2	6697	−0.6
5419	0.05	6122	1.2	6700	−0.6
5421	0.12	6124	1.19	6702	−0.75
5424	0.15	6166	1.19	6705	−0.75
5426	0.19	6169	1.2	6707	−0.91
5429	0.22	6205	1.2	6710	−0.99
5431	0.26	6208	1.21	6712	−1.07
5434	0.29	6215	1.21	6715	−1.14
5436	0.33	6218	1.22	6839	−1.14
5438	0.36	6299	1.22	6841	−1.21
5512	0.36	6301	1.21	6844	−1.28
5515	0.41	6306	1.21	6846	−1.35
5517	0.47	6308	1.19	6849	−1.42
5519	0.52	6311	1.19	6851	−1.49
5522	0.57	6313	1.18	6854	−1.56
5524	0.62	6316	1.18	6856	−1.63
5527	0.68	6318	1.17	6859	−1.7
5529	0.73	6370	1.17	6861	−1.77
5532	0.78	6372	1.16	6864	−1.84
5534	0.84	6375	1.15	6866	−1.85
5537	0.89	6377	1.15	6964	−1.85
5561	0.89	6380	1.14	6966	−1.86
5564	0.9	6382	1.14	6969	−1.87
5566	0.91	6385	1.13	6971	−1.88
5568	0.92	6387	1.13	6974	−1.9
5571	0.92	6389	1.12	6976	−1.91
5573	0.93	6392	1.11	6979	−1.92
5576	0.94	6419	1.11	6981	−1.94
5578	0.95	6421	1.07	6984	−1.95
5581	0.96	6424	1.04	6986	−1.96
5583	0.97	6426	1.04	6989	−1.98

Distance (m)	Grade (%)
7115	−1.98
7117	−1.97
7128	−1.97
7130	−1.96
7138	−1.96
7140	−1.95
7295	−1.95
7298	−1.94
7323	−1.94
7326	−1.95
7336	−1.95
7339	−1.96
7451	−1.96
7454	−1.94
7456	−1.94
7459	−1.93
7461	−1.93
7464	−1.92
7466	−1.92
7469	−1.91
7471	−1.9
7474	−1.9
7477	−1.89
7479	−1.88
7482	−1.87
7484	−1.87
7487	−1.86
7489	−1.85
7492	−1.84
7494	−1.83
7574	−1.83
7576	−1.78
7579	−1.72
7581	−1.67
7584	−1.62
7587	−1.57
7589	−1.52
7592	−1.47
7594	−1.42
7597	−1.37
7599	−1.32
7651	−1.32
7653	−1.26
7656	−1.2
7658	−1.14
7661	−1.08
7663	−1.02
7666	−0.96
7668	−0.9
7671	−0.84
7673	−0.78
7676	−0.72
7679	−0.64
7681	−0.56
7684	−0.47
7686	−0.39
7689	−0.31
7691	−0.22
7694	−0.14
7696	−0.06
7699	0.03
7701	0.11
7827	0.11
7829	0.17
7832	0.24
7834	0.3
7837	0.3
7839	0.43
7841	0.49
7844	0.56
7846	0.62
7849	0.69
7851	0.75
7949	0.75
7952	0.74
7954	0.72
7956	0.72
7959	0.7
7961	0.68
7964	0.67
7966	0.66
7969	0.64
7971	0.63
7973	0.62
7976	0.61
7983	0.61
7986	0.6
7988	0.59
7993	0.59
7995	0.58
8051	0.58
8054	0.57
8144	0.57
8147	0.58
8149	0.58
8152	0.59
8154	0.6
8157	0.6
8159	0.61
8162	0.62
8164	0.63
8167	0.63
8169	0.64
8248	0.64
8250	0.65
8265	0.65
8267	0.66
8270	0.65
8272	0.64
8275	0.63
8277	0.63
8280	0.62
8282	0.61
8285	0.61
8287	0.6
8290	0.59
8393	0.59
8395	0.6
8398	0.61
8400	0.61
8403	0.62
8405	0.63
8408	0.64
8410	0.65
8413	0.66
8440	0.66
8442	0.67
8444	0.68
8447	0.69
8449	0.7
8452	0.71
8454	0.72
8457	0.72
8459	0.73
8462	0.73
8464	0.75
8467	0.76
8469	0.77
8472	0.78
8474	0.79
8476	0.79
8479	0.8
8481	0.81
8484	0.82
8486	0.83
8489	0.84
8491	0.87
8494	0.91
8496	0.95
8499	0.98
8501	1.02
8503	1.06
8506	1.1
8508	1.13
8511	1.13
8513	1.2
8516	1.2
8518	1.24
8521	1.31
8523	1.35
8526	1.39
8528	1.42
8530	1.46
8533	1.5
8535	1.53
8538	1.57
8611	1.57
8614	1.64
8616	1.7
8618	1.77
8621	1.83
8623	1.9
8626	1.97
8628	2.03
8631	2.1
8633	2.16
8635	2.23
8662	2.23
8665	2.25
8667	2.27
8670	2.3
8672	2.32
8674	2.34
8677	2.36
8679	2.37
8682	2.39
8684	2.41
8711	2.41
8713	2.39
8716	2.35
8718	2.34
8721	2.32
8723	2.3
8725	2.28
8728	2.26
8730	2.26
8733	2.24
8735	2.22
8805	2.22
8808	2.16
8810	2.16
8812	2.05
8815	2.05
8817	1.93
8820	1.87
8822	1.81
8824	1.75
8827	1.69
8829	1.69
8831	1.64
8901	1.64
8903	1.62
8905	1.62
8908	1.57
8910	1.55
8913	1.53
8915	1.51
8917	1.49
8920	1.47

Distance (m)	Grade (%)
8922	1.45
8925	1.43
8927	1.43
8930	1.41
8932	1.39
8934	1.36
8937	1.36
8939	1.32
8942	1.32
8944	1.29
8946	1.27
8949	1.25
8951	1.23
8954	1.22
8956	1.2
8959	1.18
8961	1.16
8963	1.15
8966	1.13
8968	1.11
8971	1.09
8973	1.07
9056	1.07
9059	1.06
9066	1.06
9069	1.05
9076	1.05
9079	1.04
9086	1.04
9088	1.03
9093	1.03
9096	1.02
9304	1.02
9306	1.01
9348	1.01
9350	1
9487	1
9490	0.99
9500	0.99
9502	0.98
9547	0.98
9549	0.97
9610	0.97
9613	0.96
9706	0.96
9709	0.97
9711	0.98
9714	0.99
9716	1
9719	1
9721	1.01
9723	1.02
9726	1.03
9728	1.04
9731	1.05
9765	1.05
9768	1.06
9773	1.06
9775	1.07
9927	1.07
9930	1.06
9932	1.05
9934	1.04
9937	1.03
9939	1.02
9942	1
9944	0.99
9947	0.98
9949	0.98
9952	0.96
10006	0.96
10008	0.95
10011	0.95
10013	0.94
10015	0.93
10018	0.93
10020	0.92
10025	0.92
10028	0.91
10050	0.91
10052	0.9
10055	0.89
10057	0.89
10060	0.88
10062	0.87
10065	0.86
10067	0.85
10070	0.84
10072	0.83
10074	0.82
10148	0.82
10151	0.81
10153	0.79
10156	0.77
10158	0.76
10161	0.74
10163	0.72
10165	0.71
10168	0.69
10170	0.68
10173	0.66
10175	0.66
10178	0.63
10180	0.61
10183	0.59
10185	0.58
10188	0.56
10190	0.55
10192	0.53
10195	0.51
10197	0.5
10200	0.49
10202	0.47
10205	0.46
10207	0.45
10210	0.44
10212	0.42
10215	0.41
10217	0.4
10220	0.39
10222	0.38
10224	0.38
10227	0.35
10229	0.34
10232	0.33
10234	0.32
10237	0.3
10239	0.29
10242	0.28
10244	0.27
10247	0.26
10249	0.21
10252	0.21
10254	0.1
10256	0.05
10259	0
10261	−0.05
10264	−0.1
10266	−0.15
10269	−0.2
10271	−0.25
10370	−0.25
10373	−0.27
10375	−0.29
10378	−0.3
10380	−0.3
10383	−0.34
10385	−0.36
10387	−0.38
10390	−0.39
10392	−0.39
10395	−0.43
10397	−0.45
10400	−0.48
10402	−0.5
10405	−0.5
10407	−0.55
10410	−0.58
10412	−0.6
10415	−0.63
10417	−0.65
10420	−0.68
10422	−0.68
10425	−0.69
10427	−0.7
10429	−0.7
10432	−0.71
10434	−0.72
10437	−0.72
10439	−0.73
10442	−0.73
10444	−0.74
10494	−0.74
10496	−0.75
10499	−0.76
10501	−0.77
10504	−0.78
10506	−0.79
10509	−0.8
10511	−0.8
10514	−0.81
10516	−0.81
10519	−0.82
10521	−0.83
10583	−0.83
10585	−0.82
10605	−0.82
10608	−0.81
10667	−0.81
10669	−0.82
10672	−0.82
10674	−0.83
10677	−0.83
10679	−0.84
10682	−0.84
10684	−0.85
10687	−0.86
10689	−0.86
10692	−0.87
10716	−0.87
10719	−0.9
10721	−0.92
10724	−0.95
10726	−0.98
10729	−1
10731	−1
10734	−1.06
10736	−1.08
10739	−1.11
10741	−1.11
10744	−1.14
10840	−1.14
10843	−1.18
10845	−1.18
10848	−1.28
10850	−1.33
10853	−1.38
10855	−1.43
10858	−1.47

Distance (m)	Grade (%)	Distance (m)	Grade (%)	Distance (m)	Grade (%)
10860	−1.52	11559	−1.45	12104	−1.79
10863	−1.57	11561	−1.43	12129	−1.79
10865	−1.62	11564	−1.42	12131	−1.8
10890	−1.62	11567	−1.4	12134	−1.8
10892	−1.64	11569	−1.38	12136	−1.81
10895	−1.66	11572	−1.36	12139	−1.81
10897	−1.68	11574	−1.35	12141	−1.82
10900	−1.7	11625	−1.35	12144	−1.82
10902	−1.72	11628	−1.34	12146	−1.83
10905	−1.74	11630	−1.34	12149	−1.84
10907	−1.76	11633	−1.33	12151	−1.84
10910	−1.78	11635	−1.33	12154	−1.85
10912	−1.8	11638	−1.32	12157	−1.85
10915	−1.82	11643	−1.32	12159	−1.86
10917	−1.84	11645	−1.31	12162	−1.86
10920	−1.85	11648	−1.31	12164	−1.87
10922	−1.87	11650	−1.3	12167	−1.88
10925	−1.89	11653	−1.3	12169	−1.88
10927	−1.91	11655	−1.29	12172	−1.89
10930	−1.93	11658	−1.29	12174	−1.89
10932	−1.95	11660	−1.28	12177	−1.9
10935	−1.97	11666	−1.28	12179	−1.91
10937	−1.99	11668	−1.27	12281	−1.91
10940	−2.01	11671	−1.27	12283	−1.9
11040	−2.01	11673	−1.26	12286	−1.9
11043	−2	11746	−1.26	12288	−1.89
11048	−2	11749	−1.27	12293	−1.89
11050	−1.98	11779	−1.27	12296	−1.88
11055	−1.98	11782	−1.28	12298	−1.88
11058	−1.97	11880	−1.28	12301	−1.87
11060	−1.96	11882	−1.29	12303	−1.87
11063	−1.96	11887	−1.29	12306	−1.86
11065	−1.95	11890	−1.3	12380	−1.86
11124	−1.95	11895	−1.3	12382	−1.87
11126	−1.94	11897	−1.31	12390	−1.87
11139	−1.94	11902	−1.31	12392	−1.88
11141	−1.93	11905	−1.32	12397	−1.88
11169	−1.93	11908	−1.33	12400	−1.89
11172	−1.94	11910	−1.33	12408	−1.89
11286	−1.94	11913	−1.34	12410	−1.9
11289	−1.95	11915	−1.35	12418	−1.9
11306	−1.95	11918	−1.35	12420	−1.91
11309	−1.96	11920	−1.36	12425	−1.91
11327	−1.96	11923	−1.36	12428	−1.92
11329	−1.95	11925	−1.37	12435	−1.92
11334	−1.95	11928	−1.38	12438	−1.93
11337	−1.94	11933	−1.38	12446	−1.93
11396	−1.94	11935	−1.39	12448	−1.94
11398	−1.92	11943	−1.39	12453	−1.94
11401	−1.91	11945	−1.4	12456	−1.95
11403	−1.89	11950	−1.4	12463	−1.95
11406	−1.88	11953	−1.41	12466	−1.96
11408	−1.87	12003	−1.41	12474	−1.96
11411	−1.85	12006	−1.43	12476	−1.97
11413	−1.84	12008	−1.45	12481	−1.97
11416	−1.83	12011	−1.48	12484	−1.98
11419	−1.81	12013	−1.5	12509	−1.98
11421	−1.8	12016	−1.52	12512	−1.96
11472	−1.8	12018	−1.55	12514	−1.95
11475	−1.77	12021	−1.57	12517	−1.93
11477	−1.74	12023	−1.59	12519	−1.92
11480	−1.72	12026	−1.61	12522	−1.9
11482	−1.72	12028	−1.64	12525	−1.89
11485	−1.66	12078	−1.64	12527	−1.87
11488	−1.63	12081	−1.65	12530	−1.86
11490	−1.6	12083	−1.67	12532	−1.84
11493	−1.58	12086	−1.68	12535	−1.83
11495	−1.55	12088	−1.68	12611	−1.83
11498	−1.52	12091	−1.71	12614	−1.8
11549	−1.52	12094	−1.73	12616	−1.77
11551	−1.5	12096	−1.74	12619	−1.75
11554	−1.49	12099	−1.76	12621	−1.72
11556	−1.47	12101	−1.77	12624	−1.69

Distance (m)	Grade (%)
12626	−1.66
12629	−1.63
12632	−1.61
12634	−1.58
12637	−1.55
12639	−1.52
12642	−1.49
12644	−1.47
12647	−1.44
12649	−1.41
12652	−1.38
12655	−1.35
12657	−1.33
12660	−1.3
12662	−1.27
12665	−1.18
12667	−1.09
12670	−0.99
12672	−0.9
12675	−0.81
12677	−0.72
12680	−0.62
12683	−0.53
12685	−0.44
12688	−0.35
12791	−0.35
12793	−0.16
12796	−0.06
12798	0.03
12801	0.13
12803	0.22
12806	0.31
12808	0.41
12811	0.5
12813	0.6
12816	0.66
12818	0.72
12821	0.79
12823	0.85
12826	0.91
12828	0.97
12831	1.04
12833	1.1
12836	1.1
12838	1.22
12888	1.22
12890	1.25
12893	1.27
12895	1.29
12898	1.31
12900	1.33
12902	1.35
12905	1.37
12907	1.39
12910	1.41
12912	1.43
12999	1.43
13001	1.42
13032	1.42
13035	1.41
13039	1.41
13042	1.4
13044	1.4
13047	1.39
13049	1.39
13051	1.38
13158	1.38
13160	1.39
13163	1.39
13165	1.4
13167	1.4
13170	1.41
13175	1.41
13177	1.42
13295	1.42
13297	1.43
13332	1.43
13334	1.42
13408	1.42
13410	1.41
13504	1.41
13506	1.4
13759	1.4
13761	1.41
13864	1.41
13867	1.42
13882	1.42
13884	1.43
13896	1.43
13899	1.44
13909	1.44
13911	1.45
14029	1.45
14031	1.44
14036	1.44
14039	1.45
14044	1.45
14046	1.46
14051	1.46
14053	1.47
14058	1.47
14061	1.48
14159	1.48
14161	1.46
14164	1.44
14166	1.42
14169	1.4
14171	1.38
14174	1.36
14176	1.34
14178	1.33
14181	1.31
14183	1.29
14208	1.29
14210	1.26
14213	1.23
14215	1.19
14218	1.16
14220	1.13
14223	1.1
14225	1.07
14228	1.04
14230	1
14232	0.97
14257	0.97
14259	0.91
14262	0.85
14264	0.78
14267	0.72
14269	0.66
14272	0.59
14274	0.53
14277	0.47
14279	0.4
14282	0.34
14379	0.34
14381	0.21
14384	0.08
14386	−0.04
14389	−0.17
14391	−0.3
14393	−0.43
14396	−0.56
14398	−0.68
14401	−0.81
14403	−0.94
14526	−0.94
14528	−0.98
14531	−1.03
14533	−1.07
14536	−1.12
14538	−1.16
14541	−1.21
14543	−1.25
14546	−1.3
14548	−1.34
14551	−1.39
14678	−1.39
14680	−1.38
14685	−1.38
14687	−1.37
14695	−1.37
14697	−1.36
14802	−1.36
14805	−1.35
14807	−1.35
14810	−1.34
14815	−1.34
14817	−1.33
14820	−1.33
14823	−1.32
14828	−1.32
14830	−1.31
14835	−1.31
14838	−1.3
14843	−1.3
14845	−1.29
15028	−1.29
15031	−1.3
15038	−1.3
15041	−1.31
15048	−1.31
15051	−1.32
15076	−1.32
15078	−1.33
15081	−1.33
15083	−1.34
15086	−1.35
15088	−1.36
15091	−1.37
15093	−1.38
15096	−1.39
15098	−1.4
15226	−1.4
15229	−1.38
15231	−1.36
15234	−1.34
15236	−1.32
15239	−1.3
15241	−1.27
15244	−1.25
15246	−1.23
15249	−1.21
15251	−1.19
15352	−1.19
15354	−1.1
15357	−1
15359	−0.91
15362	−0.82
15364	−0.73
15367	−0.64
15369	−0.55
15372	−0.46
15374	−0.37
15377	−0.28
15379	−0.2
15382	−0.12
15384	−0.04
15387	0.03

Distance (m)	Grade (%)
15389	0.11
15392	0.19
15394	0.26
15397	0.34
15399	0.42
15402	0.49
15501	0.49
15503	0.59
15506	0.69
15508	0.79
15511	0.89
15513	0.99
15516	1.08
15518	1.18
15521	1.28
15523	1.38
15525	1.48
15598	1.48
15601	1.51
15603	1.55
15606	1.58
15608	1.62
15610	1.65
15613	1.68
15615	1.72
15618	1.75
15620	1.79
15623	1.82
15625	1.83
15627	1.85
15630	1.85
15632	1.87
15635	1.88
15637	1.89
15639	1.91
15642	1.92
15644	1.93
15647	1.94
15721	1.94
15723	1.93
15726	1.93
15728	1.92
15730	1.92
15733	1.91
15738	1.91
15740	1.9
15742	1.9
15745	1.89
15747	1.89
15749	1.88
15752	1.88
15754	1.87
15757	1.87
15759	1.86
15761	1.86
15764	1.85
15773	1.85
15776	1.84
15783	1.84
15785	1.83
15867	1.83
15870	1.84
15877	1.84
15879	1.85
15962	1.85
15965	1.86
15977	1.86
15979	1.87
16141	1.87
16144	1.88
16259	1.88
16262	1.89
16266	1.89
16269	1.9
16276	1.9
16279	1.91
16328	1.91
16330	1.9
16333	1.89
16335	1.88
16338	1.87
16340	1.86
16342	1.85
16345	1.85
16347	1.84
16350	1.83
16352	1.82
16377	1.82
16379	1.79
16382	1.77
16384	1.75
16387	1.72
16389	1.7
16392	1.68
16394	1.65
16396	1.63
16399	1.61
16401	1.58
16500	1.58
16502	1.54
16504	1.5
16507	1.45
16509	1.41
16512	1.36
16514	1.32
16517	1.27
16519	1.23
16522	1.19
16524	1.14
16527	1.11
16529	1.08
16531	1.05
16534	1.02
16536	1
16539	0.97
16541	0.94
16544	0.91
16546	0.88
16549	0.85
16625	0.85
16627	0.84
16630	0.83
16632	0.81
16634	0.79
16637	0.79
16639	0.77
16642	0.75
16644	0.74
16649	0.74
16651	0.73
16678	0.73
16680	0.74
16692	0.74
16695	0.75
16772	0.75
16774	0.76
16777	0.76
16779	0.77
16782	0.77
16784	0.78
16789	0.78
16791	0.79
16897	0.79
16899	0.78
16919	0.78
16921	0.77
16936	0.77
16939	0.76
17012	0.76
17015	0.77
17062	0.77
17064	0.78
17081	0.78
17084	0.79
17103	0.79
17106	0.8
17153	0.8
17155	0.81
17177	0.81
17180	0.82
17266	0.82
17268	0.81
17278	0.81
17280	0.8
17293	0.8
17295	0.79
17408	0.79
17410	0.77
17413	0.76
17415	0.75
17418	0.74
17420	0.74
17423	0.73
17425	0.72
17428	0.71
17430	0.7
17455	0.7
17457	0.68
17460	0.66
17462	0.64
17464	0.62
17467	0.59
17469	0.57
17472	0.55
17474	0.53
17477	0.51
17479	0.49
17528	0.49
17531	0.43
17533	0.37
17536	0.31
17538	0.31
17541	0.18
17543	0.12
17546	0.06
17548	0
17551	−0.06
17553	−0.12
17649	−0.12
17652	−0.13
17654	−0.27
17657	−0.42
17659	−0.42
17662	−0.71
17664	−0.86
17667	−1
17669	−1.15
17672	−1.29
17674	−1.44
17677	−1.58
17801	−1.58
17803	−1.61
17806	−1.64
17808	−1.67
17811	−1.69
17813	−1.72
17816	−1.75
17818	−1.78
17821	−1.81

Distance (m)	Grade (%)	Distance (m)	Grade (%)	Distance (m)	Grade (%)
17823	−1.83	18434	−2.04	19016	−0.18
17826	−1.86	18437	−2.04	19019	−0.1
17851	−1.86	18439	−2.03	19021	−0.02
17854	−1.87	18442	−2.02	19024	0.06
17856	−1.88	18445	−2.02	19124	0.06
17859	−1.89	18447	−2.01	19127	0.08
17861	−1.89	18450	−2.01	19129	0.1
17864	−1.9	18452	−2	19132	0.13
17866	−1.91	18455	−1.99	19134	0.15
17869	−1.92	18457	−1.99	19137	0.17
17871	−1.92	18460	−1.98	19139	0.19
17874	−1.93	18463	−1.98	19142	0.22
17876	−1.94	18465	−1.97	19144	0.24
17879	−1.93	18468	−1.96	19146	0.26
17884	−1.93	18470	−1.96	19149	0.28
17886	−1.91	18473	−1.95	19198	0.28
17889	−1.91	18475	−1.94	19201	0.29
17891	−1.9	18478	−1.94	19203	0.29
17894	−1.89	18480	−1.93	19206	0.3
17896	−1.88	18483	−1.93	19211	0.3
17899	−1.88	18486	−1.92	19213	0.31
17901	−1.87	18591	−1.92	19218	0.31
18028	−1.87	18593	−1.91	19220	0.32
18030	−1.85	18596	−1.91	19267	0.32
18033	−1.83	18598	−1.9	19269	0.33
18035	−1.83	18603	−1.9	19345	0.33
18038	−1.79	18606	−1.89	19348	0.32
18040	−1.77	18609	−1.89	19357	0.32
18043	−1.75	18611	−1.88	19360	0.31
18045	−1.73	18724	−1.88	19372	0.31
18048	−1.71	18727	−1.89	19374	0.3
18051	−1.69	18737	−1.89	19384	0.3
18053	−1.67	18739	−1.9	19387	0.29
18180	−1.67	18768	−1.9	19423	0.29
18182	−1.69	18770	−1.89	19426	0.28
18185	−1.7	18775	−1.89	19473	0.28
18188	−1.71	18778	−1.88	19475	0.29
18190	−1.72	18783	−1.88	19492	0.29
18193	−1.74	18786	−1.87	19495	0.3
18195	−1.75	18791	−1.87	19615	0.3
18198	−1.76	18793	−1.86	19618	0.31
18200	−1.78	18801	−1.86	19620	0.32
18203	−1.79	18804	−1.85	19623	0.33
18205	−1.8	18809	−1.85	19625	0.34
18231	−1.8	18811	−1.84	19628	0.35
18233	−1.81	18816	−1.84	19630	0.35
18236	−1.83	18819	−1.83	19632	0.36
18238	−1.84	18845	−1.83	19635	0.37
18241	−1.85	18847	−1.78	19637	0.38
18243	−1.87	18850	−1.72	19640	0.39
18246	−1.88	18852	−1.67	19682	0.39
18248	−1.89	18855	−1.61	19684	0.4
18251	−1.91	18858	−1.55	19704	0.4
18254	−1.92	18860	−1.5	19706	0.41
18256	−1.93	18863	−1.44	19731	0.41
18307	−1.93	18865	−1.39	19733	0.42
18309	−1.95	18868	−1.33	19817	0.42
18312	−1.96	18870	−1.28	19819	0.41
18315	−1.98	18978	−1.28	19822	0.41
18317	−1.99	18980	−1.17	19824	0.4
18320	−2	18983	−1.05	19827	0.4
18322	−2.02	18985	−1	19829	0.39
18325	−2.03	18988	−0.94	19832	0.39
18327	−2.05	18991	−0.89	19834	0.38
18330	−2.06	18993	−0.83	19937	0.38
18332	−2.08	18996	−0.78	19940	0.39
18411	−2.08	18998	−0.72	19942	0.39
18414	−2.07	19001	−0.72	19945	0.4
18416	−2.07	19003	−0.64	19947	0.4
18419	−2.06	19006	−0.49	19949	0.41
18424	−2.06	19008	−0.41	19954	0.41
18427	−2.05	19011	−0.33	19957	0.42
18432	−2.05	19013	−0.25	20058	0.42

Distance (m)	Grade (%)
20060	0.41
20063	0.39
20065	0.38
20067	0.37
20070	0.35
20072	0.34
20075	0.32
20077	0.31
20080	0.3
20082	0.28
20156	0.28
20158	0
20193	0

PART 1039—CONTROL OF EMISSIONS FROM NEW AND IN-USE NONROAD COMPRESSION-IGNITION ENGINES

■ 117. The authority citation for part 1039 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart A—Overview and Applicability

■ 118. Section 1039.2 is revised to read as follows:

§ 1039.2 Who is responsible for compliance?

The regulations in this part 1039 contain provisions that affect both manufacturers and others. However, the requirements of this part are generally addressed to the manufacturer. The term ''you'' generally means the manufacturer, as defined in § 1039.801, especially for issues related to certification. Note that for engines that become new after being placed into service (such as engines converted from highway or stationary use), the requirements that normally apply for manufacturers of freshly manufactured engines apply to the importer or any other entity we allow to obtain a certificate of conformity.

■ 119. Section 1039.5 is amended by revising the introductory text, adding paragraph (a)(2)(iii), and revising paragraph (e) to read as follows:

§ 1039.5 Which engines are excluded from this part's requirements?

This part does not apply to certain nonroad engines, as follows:

(a) * * *

(2) * * *

(iii) Locomotive engines produced under the provisions of 40 CFR 1033.625.

* * * * *

(e) *Engines used in recreational vehicles.* Engines certified to meet the requirements of 40 CFR part 1051 are not subject to the provisions of this part 1039.

■ 120. Section 1039.30 is revised to read as follows:

§ 1039.30 Submission of information.

Unless we specify otherwise, send all reports and requests for approval to the Designated Compliance Officer (see § 1039.801). See § 1039.825 for additional reporting and recordkeeping provisions.

Subpart B—Emission Standards and Related Requirements

■ 121. Section 1039.102 is amended by revising paragraph (e)(3) to read as follows:

§ 1039.102 What exhaust emission standards and phase-in allowances apply for my engines in model year 2014 and earlier?

* * * * *

(e) * * *

(3) You may use NO_X +NMHC emission credits to certify an engine family to the alternate NO_X +NMHC standards in this paragraph (e)(3) instead of the otherwise applicable alternate NO_X and NMHC standards. Calculate the alternate NO_X +NMHC standard by adding 0.1 g/kW-hr to the numerical value of the applicable alternate NO_X standard of paragraph (e)(1) or (2) of this section. Engines certified to the NO_X +NMHC standards of this paragraph (e)(3) may not generate emission credits. The FEL caps for engine families certified under this paragraph (e)(3) are the previously applicable NO_X +NMHC standards of 40 CFR 89.112 (generally the Tier 3 standards).

* * * * *

■ 122. Section 1039.104 is amended by revising paragraph (g)(5) and adding paragraph (i) to read as follows:

§ 1039.104 Are there interim provisions that apply only for a limited time?

* * * * *

(g) * * *

(5) You may certify engines under this paragraph (g) in any model year provided for in Table 1 of this section without regard to whether or not the engine family's FEL is at or below the otherwise applicable FEL cap. For example, a 200 kW engine certified to the NO_X + NMHC standard of § 1039.102(e)(3) with an FEL equal to the FEL cap of 4.0 g/kW-hr may nevertheless be certified under this paragraph (g).

* * * * *

(i) *Lead time for diagnostic controls.* Model year 2017 and earlier engines are not subject to the requirements for diagnostic controls specified in § 1039.110.

* * * * *

■ 123. Section 1039.107 is amended by revising paragraph (b)(2) to read as follows:

§ 1039.107 What evaporative emission standards and requirements apply?

* * * * *

(b) * * *

(2) Present test data to show that equipment using your engines meets the evaporative emission standards we specify in this section if you do not use design-based certification under 40 CFR 1048.245.

■ 124. Section 1039.110 is added to subpart B to read as follows:

§ 1039.110 Recording reductant use and other diagnostic functions.

(a) Engines equipped with SCR systems using a reductant other than the engine's fuel must have a diagnostic system that monitors reductant quality and tank levels and alert operators to the need to refill the reductant tank before it is empty, or to replace the reductant if it does not meet your concentration specifications. Unless we approve other alerts, use a warning lamp or an audible alarm. You do not need to separately monitor reductant quality if you include an exhaust NO_X sensor (or other sensor) that allows you to determine inadequate reductant quality. However, tank level must be monitored in all cases.

(b) You may equip your engine with other diagnostic features. If you do, they must be designed to allow us to read and interpret the codes. Note that § 1039.205 requires you to provide us any information needed to read, record, and interpret all the information broadcast by an engine's onboard computers and electronic control units.

■ 125. Section 1039.120 is amended by revising paragraph (b) introductory text to read as follows:

§ 1039.120 What emission-related warranty requirements apply to me?

* * * * *

(b) *Warranty period.* Your emission-related warranty must be valid for at least as long as the minimum warranty periods listed in this paragraph (b) in hours of operation and years, whichever comes first. You may offer an emission-related warranty more generous than we require. The emission-related warranty for the engine may not be shorter than any basic mechanical warranty you provide without charge for the engine. Similarly, the emission-related warranty for any component may not be shorter than any warranty you provide without charge for that component. This means that your warranty may not treat emission-related and nonemission-related defects differently for any component. If an engine has no hour meter, we base the warranty periods in this paragraph (b) only on the engine's age (in years). The warranty period begins when the engine is placed into service. The minimum warranty periods are shown in the following table:

* * * * *

■ 126. Section 1039.125 is amended by revising paragraphs (a)(2)(i), (a)(3)(i), (c), and (e) to read as follows:

§ 1039.125 What maintenance instructions must I give to buyers?

* * * * *

(a) * * *

(2) * * *

(i) For EGR-related filters and coolers, DEF filters, PCV valves, crankcase vent filters, and fuel injector tips (cleaning only), the minimum interval is 1,500 hours.

* * * * *

(3) * * *

(i) For EGR-related filters and coolers, DEF filters, PCV valves, crankcase vent filters, and fuel injector tips (cleaning only), the minimum interval is 1,500 hours.

* * * * *

(c) *Special maintenance.* You may specify more frequent maintenance to address problems related to special situations, such as atypical engine operation. You must clearly state that this additional maintenance is associated with the special situation you are addressing. You may also address maintenance of low-use engines (such as recreational or stand-by engines) by specifying the maintenance interval in terms of calendar months or years in addition to your specifications in terms of engine operating hours. All special maintenance instructions must be consistent with good engineering judgment. We may disapprove your maintenance instructions if we determine that you have specified special maintenance steps to address maintenance that is unlikely to occur in use, or engine operation that is not atypical. For example, this paragraph (c) does not allow you to design engines that require special maintenance for a certain type of expected operation. If we determine that certain maintenance items do not qualify as special maintenance under this paragraph (c), you may identify this as recommended additional maintenance under paragraph (b) of this section.

* * * * *

(e) *Maintenance that is not emission-related.* For maintenance unrelated to emission controls, you may schedule any amount of inspection or maintenance. You may also take these inspection or maintenance steps during service accumulation on your emission-data engines, as long as they are reasonable and technologically necessary. This might include adding engine oil, changing air, fuel, or oil filters, servicing engine-cooling systems or fuel-water separator cartridges or elements, and adjusting idle speed, governor, engine bolt torque, valve lash, or injector lash. You may not perform this nonemission-related maintenance on emission-data engines more often than the least frequent intervals that you recommend to the ultimate purchaser.

* * * * *

■ 127. Section 1039.130 is amended by adding paragraph (b)(4) and revising paragraph (b)(5) to read as follows:

§ 1039.130 What installation instructions must I give to equipment manufacturers?

* * * * *

(b) * * *

(4) Describe any necessary steps for installing the diagnostic system described in § 1039.110.

(5) Describe how your certification is limited for any type of application. For example, if your engines are certified only for constant-speed operation, tell equipment manufacturers not to install the engines in variable-speed applications.

* * * * *

■ 128. Section 1039.135 is amended by revising paragraphs (c)(2) and (d) to read as follows:

§ 1039.135 How must I label and identify the engines I produce?

* * * * *

(c) * * *

(2) Include your full corporate name and trademark. You may identify another company and use its trademark instead of yours if you comply with the branding provisions of 40 CFR 1068.45.

* * * * *

(d) You may add information to the emission control information label as follows:

(1) If your emission control information label includes all the information described in paragraphs (c)(5) through (10) of this section, you may identify other emission standards that the engine meets or does not meet (such as international standards). You may include this information by adding it to the statement we specify or by including a separate statement.

(2) You may add other information to ensure that the engine will be properly maintained and used.

(3) You may add appropriate features to prevent counterfeit labels. For example, you may include the engine's unique identification number on the label.

* * * * *

Subpart C—Certifying Engine Families

■ 129. Section 1039.201 is amended by revising paragraphs (a) and (g) to read as follows:

§ 1039.201 What are the general requirements for obtaining a certificate of conformity?

(a) You must send us a separate application for a certificate of conformity for each engine family. A certificate of conformity is valid for new production from the indicated effective date until the end of the model year for which it is issued, which may not extend beyond December 31 of that year. No new certificate will be issued after December 31 of the model year. You may amend your application for certification after the end of the model year in certain circumstances as described in §§ 1039.220 and 1039.225. You must renew your certification annually for any engines you continue to produce.

* * * * *

(g) We may require you to deliver your test engines to a facility we designate for our testing (see § 1039.235(c)). Alternatively, you may choose to deliver another engine that is identical in all material respects to the test engine, or another engine that we determine can appropriately serve as an emission-data engine for the engine family.

* * * * *

■ 130. Section 1039.205 is amended by revising paragraph (r)(1) and adding paragraph (bb) to read as follows:

§ 1039.205 What must I include in my application?

* * * * *

(r) * * *

(1) Report all valid test results involving measurement of pollutants for which emission standards apply. Also indicate whether there are test results from invalid tests or from any other tests of the emission-data engine, whether or not they were conducted according to the test procedures of subpart F of this part. We may require you to report these additional test results. We may ask you to send other information to confirm that your tests were valid under the requirements of this part and 40 CFR part 1065.

* * * * *

(bb) For imported engines or equipment, identify the following:

(1) Describe your normal practice for importing engines. For example, this

may include identifying the names and addresses of any agents you have authorized to import your engines.

(2) For engines below 560 kW, identify a test facility in the United States where you can test your engines if we select them for testing under a selective enforcement audit, as specified in 40 CFR part 1068, subpart E.

■ 131. Section 1039.220 is amended by revising the section heading as to read as follows:

§ 1039.220 How do I amend my maintenance instructions?

* * * * *

■ 132. Section 1039.225 is amended by revising the introductory text and adding paragraph (b)(4) to read as follows:

§ 1039.225 How do I amend my application for certification?

Before we issue you a certificate of conformity, you may amend your application to include new or modified engine configurations, subject to the provisions of this section. After we have issued your certificate of conformity, but before the end of the model year, you may send us an amended application requesting that we include new or modified engine configurations within the scope of the certificate, subject to the provisions of this section. Before the end of the model year, you must amend your application if any changes occur with respect to any information that is included or should be included in your application. After the end of the model year, you may amend your application only to update maintenance instructions as described in § 1039.220 or to modify an FEL as described in paragraph (f) of this section.

* * * * *

(b) * * *

(4) Include any other information needed to make your application correct and complete.

* * * * *

■ 133. Section 1039.230 is amended by revising paragraph (b)(1) to read as follows:

§ 1039.230 How do I select engine families?

* * * * *

(b) * * *

(1) The combustion cycle and fuel. However, you do not need to separate dual-fuel and flexible-fuel engines into separate engine families.

* * * * *

■ 134. Section 1039.235 is amended by revising paragraphs (a), (b), (c)(4), and (d)(1) to read as follows:

§ 1039.235 What testing requirements apply for certification?

* * * * *

(a) Select an emission-data engine from each engine family for testing. Select the engine configuration with the highest volume of fuel injected per cylinder per combustion cycle at the point of maximum torque—unless good engineering judgment indicates that a different engine configuration is more likely to exceed (or have emissions nearer to) an applicable emission standard or FEL. If two or more engines have the same fueling rate at maximum torque, select the one with the highest fueling rate at rated speed. In making this selection, consider all factors expected to affect emission-control performance and compliance with the standards, including emission levels of all exhaust constituents, especially NO_X and PM.

(b) Test your emission-data engines using the procedures and equipment specified in subpart F of this part. In the case of dual-fuel engines, measure emissions when operating with each type of fuel for which you intend to certify the engine. In the case of flexible-fuel engines, measure emissions when operating with the fuel mixture that best represents in-use operation or is most likely to have the highest NO_X emissions (or NO_X+NMHC emissions for engines subject to NO_X+NMHC standards), though you may ask us instead to perform tests with both fuels separately if you can show that intermediate mixtures are not likely to occur in use.

* * * * *

(c) * * *

(4) Before we test one of your engines, we may calibrate it within normal production tolerances for anything we do not consider an adjustable parameter. For example, this would apply for an engine parameter that is subject to production variability because it is adjustable during production, but is not considered an adjustable parameter (as defined in § 1039.801) because it is permanently sealed. For parameters that relate to a level of performance that is itself subject to a specified range (such as maximum power output), we will generally perform any calibration under this paragraph (c)(4) in a way that keeps performance within the specified range.

(d) * * *

(1) The engine family from the previous model year differs from the current engine family only with respect to model year, items identified in § 1039.225(a), or other characteristics unrelated to emissions. We may waive this criterion for differences we determine not to be relevant.

* * * * *

■ 135. Section 1039.240 is amended by revising paragraphs (c) and (d) and removing paragraph (e).

The revisions read as follows:

§ 1039.240 How do I demonstrate that my engine family complies with exhaust emission standards?

* * * * *

(c) To compare emission levels from the emission-data engine with the applicable emission standards, apply deterioration factors to the measured emission levels for each pollutant. Section 1039.245 specifies how to test your engine to develop deterioration factors that represent the deterioration expected in emissions over your engines' full useful life. Your deterioration factors must take into account any available data from in-use testing with similar engines. Small-volume engine manufacturers may use assigned deterioration factors that we establish. Apply deterioration factors as follows:

(1) *Additive deterioration factor for exhaust emissions.* Except as specified in paragraph (c)(2) of this section, use an additive deterioration factor for exhaust emissions. An additive deterioration factor is the difference between exhaust emissions at the end of the useful life and exhaust emissions at the low-hour test point. In these cases, adjust the official emission results for each tested engine at the selected test point by adding the factor to the measured emissions. If the factor is less than zero, use zero. Additive deterioration factors must be specified to one more decimal place than the applicable standard.

(2) *Multiplicative deterioration factor for exhaust emissions.* Use a multiplicative deterioration factor if good engineering judgment calls for the deterioration factor for a pollutant to be the ratio of exhaust emissions at the end of the useful life to exhaust emissions at the low-hour test point. For example, if you use aftertreatment technology that controls emissions of a pollutant proportionally to engine-out emissions, it is often appropriate to use a multiplicative deterioration factor. Adjust the official emission results for each tested engine at the selected test point by multiplying the measured emissions by the deterioration factor. If the factor is less than one, use one. A multiplicative deterioration factor may not be appropriate in cases where testing variability is significantly greater than engine-to-engine variability. Multiplicative deterioration factors must

be specified to one more significant figure than the applicable standard.

(3) *Sawtooth deterioration patterns.* The deterioration factors described in paragraphs (c)(1) and (2) of this section assume that the highest useful life emissions occur either at the end of useful life or at the low-hour test point. The provisions of this paragraph (c)(3) apply where good engineering judgment indicates that the highest emissions over the useful life will occur between these two points. For example, emissions may increase with service accumulation until a certain maintenance step is performed, then return to the low-hour emission levels and begin increasing again. Base deterioration factors for engines with such emission patterns on the difference between (or ratio of) the point of the sawtooth at which the highest emissions occur and the low-hour test point. Note that this applies for maintenance-related deterioration only where we allow such critical emission-related maintenance.

(4) *Deterioration factor for smoke.* Deterioration factors for smoke are always additive, as described in paragraph (c)(1) of this section.

(5) *Deterioration factor for crankcase emissions.* If your engine vents crankcase emissions to the exhaust or to the atmosphere, you must account for crankcase emission deterioration, using good engineering judgment. You may use separate deterioration factors for crankcase emissions of each pollutant (either multiplicative or additive) or include the effects in combined deterioration factors that include exhaust and crankcase emissions together for each pollutant.

(6) *Dual-fuel and flexible-fuel engines.* In the case of dual-fuel and flexible-fuel engines, apply deterioration factors separately for each fuel type. You may accumulate service hours on a single emission-data engine using the type of fuel or the fuel mixture expected to have the highest combustion and exhaust temperatures; you may ask us to approve a different fuel mixture if you demonstrate that a different criterion is more appropriate.

(d) Determine the official emission result for each pollutant to at least one more decimal place than the applicable standard. Apply the deterioration factor to the official emission result, as described in paragraph (c) of this section, then round the adjusted figure to the same number of decimal places as the emission standard. Compare the rounded emission levels to the emission standard for each emission-data engine. In the case of NO_X+NMHC standards, apply the deterioration factor to each pollutant and then add the results before rounding.

* * * * *

■ 136. Section 1039.250 is amended by revising paragraphs (b)(3)(iv) and (c) to read as follows:

§ 1039.250 What records must I keep and what reports must I send to EPA?

* * * * *

(b) * * *

(3) * * *

(iv) All your emission tests, including the date and purpose of each test and documentation of test parameters as specified in part 40 CFR part 1065.

* * * * *

(c) Keep required data from emission tests and all other information specified in this section for eight years after we issue your certificate. If you use the same emission data or other information for a later model year, the eight-year period restarts with each year that you continue to rely on the information.

* * * * *

■ 137. Section 1039.255 is amended by revising paragraphs (c)(2), (c)(4), (d), and (e) to read as follows:

§ 1039.255 What decisions may EPA make regarding my certificate of conformity?

* * * * *

(c) * * *

(2) Submit false or incomplete information (paragraph (e) of this section applies if this is fraudulent). This includes doing anything after submission of your application to render any of the submitted information false or incomplete.

* * * * *

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

* * * * *

(d) We may void the certificate of conformity for an engine family if you fail to keep records, send reports, or give us information as required under this part or the Act. Note that these are also violations of 40 CFR 1068.101(a)(2).

(e) We may void your certificate if we find that you intentionally submitted false or incomplete information. This includes rendering submitted information false or incomplete after submission.

* * * * *

Subpart F—Test Procedures

■ 138. Section 1039.501 is amended by revising paragraphs (e), (f), and (g) and adding paragraph (h) to read as follows:

§ 1039.501 How do I run a valid emission test?

* * * * *

(e) The following provisions apply for engines using aftertreatment technology with infrequent regeneration events that may occur during testing:

(1) Adjust measured emissions to account for aftertreatment technology with infrequent regeneration as described in § 1039.525.

(2) If your engine family includes engines with one or more emergency AECDs approved under § 1039.115(g)(4) or (5), do not consider additional regenerations resulting from those AECDs when developing adjustments to measured values under this paragraph (e).

(3) Invalidate a smoke test if active regeneration starts to occur during the test.

(f) You may disable any AECDs that have been approved solely for emergency equipment applications under § 1039.115(g)(4). Note that the emission standards do not apply when any of these AECDs are active.

(g) You may use special or alternate procedures to the extent we allow them under 40 CFR 1065.10.

(h) This subpart is addressed to you as a manufacturer, but it applies equally to anyone who does testing for you, and to us when we perform testing to determine if your engines meet emission standards.

■ 139. Section 1039.505 is amended by revising paragraph (b)(2) to read as follows:

§ 1039.505 How do I test engines using steady-state duty cycles, including ramped-modal testing?

* * * * *

(b) * * *

(2) Use the 6-mode duty cycle or the corresponding ramped-modal cycle described in paragraph (b) of Appendix II of this part for variable-speed engines below 19 kW. You may instead use the 8-mode duty cycle or the corresponding ramped-modal cycle described in paragraph (c) of Appendix II of this part if some engines from your engine family will be used in applications that do not involve governing to maintain engine operation around rated speed.

* * * * *

■ 140. Section 1039.515 is amended by revising paragraph (a) to read as follows:

§ 1039.515 What are the test procedures related to not-to-exceed standards?

(a) *General provisions.* The provisions in 40 CFR 86.1370 apply for determining whether an engine meets the not-to-exceed emission standards in § 1039.101(e), except as noted in this section. Interpret references to vehicles and vehicle operation to mean equipment and equipment operation.

* * * * *

■ 141. Section 1039.525 is revised to read as follows:

§ 1039.525 How do I adjust emission levels to account for infrequently regenerating aftertreatment devices?

For engines using aftertreatment technology with infrequent regeneration events that may occur during testing, take one of the following approaches to account for the emission impact of regeneration:

(a) You may use the calculation methodology described in 40 CFR 1065.680 to adjust measured emission results. Do this by developing an upward adjustment factor and a downward adjustment factor for each pollutant based on measured emission data and observed regeneration frequency as follows:

(1) Adjustment factors should generally apply to an entire engine family, but you may develop separate adjustment factors for different configurations within an engine family. Use the adjustment factors from this section for all testing for the engine family.

(2) You may use carryover or carry-across data to establish adjustment factors for an engine family as described in § 1039.235, consistent with good engineering judgment.

(3) For engines that are required to certify to both transient and steady-state duty cycles, calculate a separate adjustment factor for steady-state and transient operation.

(b) You may ask us to approve an alternate methodology to account for regeneration events. We will generally limit approval to cases where your engines use aftertreatment technology with extremely infrequent regeneration and you are unable to apply the provisions of this section.

(c) You may choose to make no adjustments to measured emission results if you determine that regeneration does not significantly affect emission levels for an engine family (or configuration) or if it is not practical to identify when regeneration occurs. If you choose not to make adjustments under paragraph (a) or (b) of this section, your engines must meet emission standards for all testing, without regard to regeneration.

Subpart G—Special Compliance Provisions

■ 142. Section 1039.601 is revised to read as follows:

§ 1039.601 What compliance provisions apply?

(a) Engine and equipment manufacturers, as well as owners, operators, and rebuilders of engines subject to the requirements of this part, and all other persons, must observe the provisions of this part, the requirements and prohibitions in 40 CFR part 1068, and the provisions of the Act.

(b) Subpart C of this part describes how to test and certify dual-fuel and flexible-fuel engines. Some multi-fuel engines may not fit either of those defined terms. For such engines, we will determine whether it is most appropriate to treat them as single-fuel engines, dual-fuel engines, or flexible-fuel engines based on the range of possible and expected fuel mixtures. For example, an engine might burn natural gas but initiate combustion with a pilot injection of diesel fuel. If the engine is designed to operate with a single fueling algorithm (*i.e.,* fueling rates are fixed at a given engine speed and load condition), we would generally treat it as a single-fuel engine, In this context, the combination of diesel fuel and natural gas would be its own fuel type. If the engine is designed to also operate on diesel fuel alone, we would generally treat it as a dual-fueled engine. If the engine is designed to operate on varying mixtures of the two fuels, we would generally treat it as a flexible-fueled engine. To the extent that requirements vary for the different fuels or fuel mixtures, we may apply the more stringent requirements.

■ 143. Section 1039.605 is amended by revising paragraphs (b), (d)(5), and (d)(8) to read as follows:

§ 1039.605 What provisions apply to engines certified under the motor-vehicle program?

* * * * *

(b) *Equipment-manufacturer provisions.* If you are not an engine manufacturer, you may install motor-vehicle engines certified for the appropriate model year under 40 CFR part 86 in nonroad equipment as long as you meet all the requirements and conditions specified in paragraph (d) of this section. You must also add the fuel-inlet label we specify in § 1039.135(e). If you modify the motor-vehicle engine in any of the ways described in paragraph (d)(2) of this section, we will consider you a manufacturer of a new nonroad engine. Such engine modifications prevent you from using the provisions of this section.

* * * * *

(d) * * *

(5) You must add a permanent supplemental label to the engine in a position where it will remain clearly visible after installation in the equipment. In the supplemental label, do the following:

(i) Include the heading: ''NONROAD ENGINE EMISSION CONTROL INFORMATION''.

(ii) Include your full corporate name and trademark. You may identify another company and use its trademark instead of yours if you comply with the branding provisions of 40 CFR 1068.45.

(iii) State: ''THIS ENGINE WAS ADAPTED FOR NONROAD USE WITHOUT AFFECTING ITS EMISSION CONTROLS. THE EMISSION–CONTROL SYSTEM DEPENDS ON THE USE OF FUEL MEETING SPECIFICATIONS THAT APPLY FOR MOTOR–VEHICLE APPLICATIONS. OPERATING THE ENGINE ON OTHER FUELS MAY BE A VIOLATION OF FEDERAL LAW.''

(iv) State the date you finished modifying the engine (month and year), if applicable.

* * * * *

(8) Send the Designated Compliance Officer written notification describing your plans before using the provisions of this section. In addition, by February 28 of each calendar year (or less often if we tell you), send the Designated Compliance Officer a signed letter with all the following information:

(i) Identify your full corporate name, address, and telephone number.

(ii) List the engine or equipment models for which you used this exemption in the previous year and describe your basis for meeting the sales restrictions of paragraph (d)(3) of this section.

(iii) State: ''We prepared each listed [engine or equipment] model for nonroad application without making any changes that could increase its certified emission levels, as described in 40 CFR 1039.605.''

* * * * *

144. Section 1039.610 is amended by revising paragraphs (d)(5)(ii) and (d)(7) to read as follows:

§ 1039.610 What provisions apply to vehicles certified under the motor-vehicle program?

* * * * *

(d) * * *

(5) * * *

(ii) Include your full corporate name and trademark. You may identify another company and use its trademark instead of yours if you comply with the branding provisions of 40 CFR 1068.45.

* * * * *

(7) Send the Designated Compliance Officer written notification describing

your plans before using the provisions of this section. In addition, by February 28 of each calendar year (or less often if we tell you), send the Designated Compliance Officer a signed letter with all the following information:

(i) Identify your full corporate name, address, and telephone number.

(ii) List the equipment models for which you used this exemption in the previous year and describe your basis for meeting the sales restrictions of paragraph (d)(3) of this section.

(iii) State: ''We prepared each listed engine or equipment model for nonroad application without making any changes that could increase its certified emission levels, as described in 40 CFR 1039.610.''

* * * * *

Remove § 1039.640—[Removed]

■ 145. Section 1039.640 is removed.

Subpart H—Averaging, Banking, and Trading for Certification

■ 146. Section 1039.701 is amended by adding paragraph (h) to read as follows:

§ 1039.701 General provisions.

* * * * *

(h) You may use either of the following approaches to retire or forego emission credits:

(1) You may retire emission credits generated from any number of your engines. This may be considered donating emission credits to the environment. Identify any such credits in the reports described in § 1039.730. Engines must comply with the applicable FELs even if you donate or sell the corresponding emission credits under this paragraph (h). Those credits may no longer be used by anyone to demonstrate compliance with any EPA emission standards.

(2) You may certify a family using an FEL below the emission standard as described in this part and choose not to generate emission credits for that family. If you do this, you do not need to calculate emission credits for those families and you do not need to submit or keep the associated records described in this subpart for that family.

■ 147. Section 1039.705 is amended by revising paragraphs (b), (c) introductory text, and (c)(1) to read as follows:

§ 1039.705 How do I generate and calculate emission credits?

* * * * *

(b) For each participating family, calculate positive or negative emission credits relative to the otherwise applicable emission standard. Calculate positive emission credits for a family that has an FEL below the standard. Calculate negative emission credits for a family that has an FEL above the standard. Sum your positive and negative credits for the model year before rounding. Round the sum of emission credits to the nearest kilogram (kg), using consistent units throughout the following equation:

$$\text{Emission credits (kg)} = (\text{Std} - \text{FEL}) \prec (\text{Volume}) \prec (\text{AvgPR}) \prec (\text{UL}) \prec (10^{-3})$$

Where:

Std = the emission standard, in grams per kilowatt-hour, that applies under subpart B of this part for engines not participating in the ABT program of this subpart (the ''otherwise applicable standard'').

FEL = the family emission limit for the engine family, in grams per kilowatt-hour.

Volume = the number of engines eligible to participate in the averaging, banking, and trading program within the given engine family during the model year, as described in paragraph (c) of this section.

AvgPR = the average of maximum engine power values of all the engine configurations within an engine family, calculated on a sales-weighted basis, in kilowatts.

UL = the useful life for the given engine family, in hours.

(c) As described in § 1039.730, compliance with the requirements of this subpart is determined at the end of the model year based on actual U.S.-directed production volumes. Do not include any of the following engines to calculate emission credits:

(1) Engines with a permanent exemption under subpart G of this part or under 40 CFR part 1068.

* * * * *

■ 148. Section 1039.710 is amended by revising paragraph (c) to read as follows:

§ 1039.710 How do I average emission credits?

* * * * *

(c) If you certify an engine family to an FEL that exceeds the otherwise applicable standard, you must obtain enough emission credits to offset the engine family's deficit by the due date for the final report required in § 1039.730. The emission credits used to address the deficit may come from your other engine families that generate emission credits in the same model year, from emission credits you have banked from previous model years, or from emission credits generated in the same or previous model years that you obtained through trading.

■ 149. Section 1039.725 is amended by revising paragraph (b)(2) to read as follows:

§ 1039.725 What must I include in my application for certification?

* * * * *

(b) * * *

(2) Detailed calculations of projected emission credits (positive or negative) based on projected production volumes. We may require you to include similar calculations from your other engine families to demonstrate that you will be able to avoid negative credit balances for the model year. If you project negative emission credits for a family, state the source of positive emission credits you expect to use to offset the negative emission credits.

■ 150. Section 1039.730 is amended by revising paragraphs (b)(1), (b)(4), and (c)(2) to read as follows:

§ 1039.730 What ABT reports must I send to EPA?

* * * * *

(b) * * *

(1) Engine-family designation and averaging set.

* * * * *

(4) The projected and actual U.S.-directed production volumes for the model year. If you changed an FEL during the model year, identify the actual U.S.-directed production volume associated with each FEL.

* * * * *

(c) * * *

(2) State whether you will retain any emission credits for banking. If you choose to retire emission credits that would otherwise be eligible for banking, identify the engine families that generated the emission credits, including the number of emission credits from each family.

* * * * *

■ 151. Section 1039.735 is amended by revising paragraphs (a) and (b) to read as follows:

§ 1039.735 What records must I keep?

(a) You must organize and maintain your records as described in this section.

(b) Keep the records required by this section for at least eight years after the due date for the end-of-year report. You may not use emission credits for any engines if you do not keep all the records required under this section. You must therefore keep these records to continue to bank valid credits.

* * * * *

■ 152. Section 1039.740 is amended by revising paragraph (a) to read as follows:

§ 1039.740 What restrictions apply for using emission credits?

* * * * *

(a) *Averaging sets.* Emission credits may be exchanged only within an averaging set. For emission credits generated by Tier 4 engines, there are two averaging sets—one for engines at or below 560 kW and another for engines above 560 kW.

* * * * *

Subpart I—Definitions and Other Reference Information

■ 153. Section 1039.801 is amended as follows:

■ a. By revising the definitions of ''Aircraft'' and ''Designated Compliance Officer''.

■ b. By removing the definition for ''Designated Enforcement Officer''.

■ c. By adding definitions for ''Dual-fuel'' and ''Flexible-fuel''.

■ d. By revising paragraph (1)(i) of the definition of ''Model year'' and the definition of ''Placed into service''.

■ e. By removing the definition for ''Point of first retail sale''.

The revisions and additions read as follows:

§ 1039.801 What definitions apply to this part?

* * * * *

Aircraft means any vehicle capable of sustained air travel more than 100 feet above the ground.

* * * * *

Designated Compliance Officer means the Director, Diesel Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *complianceinfo@epa.gov; epa.gov/otaq/verify.*

* * * * *

Dual-fuel means relating to an engine designed for operation on two different fuels but not on a continuous mixture of those fuels (see § 1039.601(b)). For purposes of this part, such an engine remains a dual-fuel engine even if it is designed for operation on three or more different fuels.

* * * * *

Flexible-fuel means relating to an engine designed for operation on any mixture of two or more different fuels (see § 1039.601(b)).

* * * * *

Model year means one of the following things:

(1) * * *

(i) Calendar year of production.

* * * * *

Placed into service means put into initial use for its intended purpose. Engines and equipment do not qualify as being ''placed into service'' based on incidental use by a manufacturer or dealer.

* * * * *

■ 154. Section 1039.815 is revised to read as follows:

§ 1039.815 What provisions apply to confidential information?

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

■ 155. Section 1039.825 is revised to read as follows:

§ 1039.825 What reporting and recordkeeping requirements apply under this part?

(a) This part includes various requirements to submit and record data or other information. Unless we specify otherwise, store required records in any format and on any media and keep them readily available for eight years after you send an associated application for certification, or eight years after you generate the data if they do not support an application for certification. You are expected to keep your own copy of required records rather than relying on someone else to keep records on your behalf. We may review these records at any time. You must promptly send us organized, written records in English if we ask for them. We may require you to submit written records in an electronic format.

(b) The regulations in § 1039.255, 40 CFR 1068.25, and 40 CFR 1068.101 describe your obligation to report truthful and complete information. This includes information not related to certification. Failing to properly report information and keep the records we specify violates 40 CFR 1068.101(a)(2), which may involve civil or criminal penalties.

(c) Send all reports and requests for approval to the Designated Compliance Officer (see § 1039.801).

(d) Any written information we require you to send to or receive from another company is deemed to be a required record under this section. Such records are also deemed to be submissions to EPA. We may require you to send us these records whether or not you are a certificate holder.

(e) Under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*), the Office of Management and Budget approves the reporting and recordkeeping specified in the applicable regulations. The following items illustrate the kind of reporting and recordkeeping we require for engines and equipment regulated under this part:

(1) We specify the following requirements related to engine certification in this part 1039:

(i) In § 1039.20 we require engine manufacturers to label stationary engines that do not meet the standards in this part.

(ii) In § 1039.135 we require engine manufacturers to keep certain records related to duplicate labels sent to equipment manufacturers.

(iii) [Reserved]

(iv) In subpart C of this part we identify a wide range of information required to certify engines.

(v) [Reserved]

(vi) In subpart G of this part we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various special compliance provisions. For example, equipment manufacturers must submit reports and keep records related to the flexibility provisions in § 1039.625.

(vii) In § 1039.725, 1039.730, and 1039.735 we specify certain records related to averaging, banking, and trading.

(2) We specify the following requirements related to testing in 40 CFR part 1065:

(i) In 40 CFR 1065.2 we give an overview of principles for reporting information.

(ii) In 40 CFR 1065.10 and 1065.12 we specify information needs for establishing various changes to published test procedures.

(iii) In 40 CFR 1065.25 we establish basic guidelines for storing test information.

(iv) In 40 CFR 1065.695 we identify the specific information and data items to record when measuring emissions.

(3) We specify the following requirements related to the general compliance provisions in 40 CFR part 1068:

(i) In 40 CFR 1068.5 we establish a process for evaluating good engineering judgment related to testing and certification.

(ii) In 40 CFR 1068.25 we describe general provisions related to sending and keeping information.

(iii) In 40 CFR 1068.27 we require manufacturers to make engines available for our testing or inspection if we make such a request.

(iv) In 40 CFR 1068.105 we require equipment manufacturers to keep certain records related to duplicate labels from engine manufacturers.

(v) In 40 CFR 1068.120 we specify recordkeeping related to rebuilding engines.

(vi) In 40 CFR part 1068, subpart C, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various exemptions.

(vii) In 40 CFR part 1068, subpart D, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to importing engines.

(viii) In 40 CFR 1068.450 and 1068.455 we specify certain records related to testing production-line engines in a selective enforcement audit.

(ix) In 40 CFR 1068.501 we specify certain records related to investigating and reporting emission-related defects.

(x) In 40 CFR 1068.525 and 1068.530 we specify certain records related to recalling nonconforming engines.

PART 1042—CONTROL OF EMISSIONS FROM NEW AND IN–USE MARINE COMPRESSION–IGNITION ENGINES AND VESSELS

■ 156. The authority citation for part 1042 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart A—Overview and Applicability

■ 157. Section 1042.1 is amended by revising paragraphs (a) and (c) introductory text to read as follows:

§ 1042.1 Applicability.

* * * * *

(a) The emission standards of this part 1042 for freshly manufactured engines apply for new marine engines starting with the model years noted in the following table:

TABLE 1 TO § 1042.1—PART 1042 APPLICABILITY BY MODEL YEAR

Engine category	Maximum engine power[a]	Displacement (L/cyl) or application	Model year
Category 1	kW <75	disp.< 0.9	[b] 2009
	75 ≤ kW ≤ 3700	disp.< 0.9	2012
		0.9 ≤ disp. < 1.2	2013
		1.2 ≤ disp. < 2.5	2014
		2.5 ≤ disp. < 3.5	2013
		3.5 ≤ disp. < 7.0	2012
	kW > 3700	All	2014
Category 2	kW ≤ 3700	7.0 ≤ disp. < 15.0	2013
	kW > 3700	7.0 ≤ disp. < 15.0	2014
	All	15 ≤ disp. < 30	2014
Category 3	All	disp. ≥ 30	2011

[a] See § 1042.140, which describes how to determine maximum engine power.
[b] See Table 1 of § 1042.101 for the first model year in which this part 1042 applies for engines with maximum engine power below 75 kW and displacement at or above 0.9 L/cyl.

* * * * *

(c) Freshly manufactured engines with maximum engine power at or above 37 kW and originally manufactured and certified before the model years identified in Table 1 to this section are subject to emission standards and requirements of 40 CFR part 94. The provisions of this part 1042 do not apply for such engines certified under 40 CFR part 94, except as follows beginning June 29, 2010:

* * * * *

■ 158. Section 1042.2 is revised to read as follows:

§ 1042.2 Who is responsible for compliance?

The regulations in this part 1042 contain provisions that affect both engine manufacturers and others. However, the requirements of this part, other than those of subpart I of this part, are generally addressed to the engine manufacturer for freshly manufactured marine engines or other certificate holders. The term ''you'' generally means the engine manufacturer, as defined in § 1042.901, especially for issues related to certification (including production-line testing, reporting, etc.). Note that for engines that become new after being placed into service (such as engines converted from highway or stationary use, or engines installed on vessels that are reflagged to become U.S. vessels), the requirements that normally apply for manufacturers of freshly manufactured engines apply to the importer or any other entity we allow to obtain a certificate of conformity.

■ 159. Section 1042.30 is revised to read as follows:

§ 1042.30 Submission of information.

Unless we specify otherwise, send all reports and requests for approval to the Designated Compliance Officer (see § 1042.901). See § 1042.925 for additional reporting and recordkeeping provisions.

Subpart B—Emission Standards and Related Requirements

■ 160. Section 1042.101 is amended by revising the section heading and paragraphs (a), (b), and (c) to read as follows:

§ 1042.101 Exhaust emission standards for Category 1 and Category 2 engines.

(a) *Duty-cycle standards.* Exhaust emissions from your engines may not exceed emission standards, as follows:

(1) Measure emissions using the test procedures described in subpart F of this part.

(2) The following CO emission standards in this paragraph (a)(2) apply starting with the applicable model year identified in § 1042.1:

(i) 8.0 g/kW-hr for engines below 8 kW.

(ii) 6.6 g/kW-hr for engines at or above 8 kW and below 19 kW.

(iii) 5.5 g/kW-hr for engines at or above 19 kW and below 37 kW.

(iv) 5.0 g/kW-hr for engines at or above 37 kW.

(3) Except as described in paragraphs (a)(4) and (5) of this section, the Tier 3 standards for PM and NO_X+HC emissions are described in the following tables:

TABLE 1 TO § 1042.101—TIER 3 STANDARDS FOR CATEGORY 1 ENGINES BELOW 3700 kW[a]

Power density and application	Displacement (L/cyl)	Maximum engine power	Model year	PM (g/kW-hr)	NO_X+HC (g/kW-hr)[b]
all	disp. < 0.9	kW < 19	2009+	0.40	7.5
		19 > kW < 75	2009–2013	0.30	7.5
			2014+	[c] 0.30	[c] 4.7

TABLE 1 TO § 1042.101—TIER 3 STANDARDS FOR CATEGORY 1 ENGINES BELOW 3700 kW [a]—Continued

Power density and application	Displacement (L/cyl)	Maximum engine power	Model year	PM (g/kW-hr)	NO_X+HC (g/kW-hr) [b]
Commercial engines with kW/L ≤35.	disp. < 0.9	kW ≥ 75	2012+	0.14	5.4
	0.9 ≤ disp. < 1.2	all	2013+	0.12	5.4
	1.2 ≤ disp. < 2.5	kW < 600	2014–2017	0.11	5.6
			2018+	0.10	5.6
		kW ≥ 600.	2014+	0.11	5.6
	2.5 > disp. < 3.5	kW < 600	2013–2017	0.11	5.6
			2018+	0.10	5.6
		kW ≥ 600	2013+	0.11	5.6
Commercial engines with kW/L >35, and all recreational engines ≥75 kW.	disp. < 0.9	kW ≥ 75	2012+	0.15	5.8
	0.9 ≤ disp. < 1.2	all	2013+	0.14	5.8
	1.2 ≤ disp. < 2.5		2014+	0.12	5.8
	2.5 > disp. < 3.5		2013+	0.12	5.8
	3.5 > disp. < 7.0		2012+	0.11	5.8

[a] No Tier 3 standards apply for commercial Category 1 engines at or above 3700 kW. See § 1042.1(c) and paragraph (a)(7) of this section for the standards that apply for these engines.

[b] The applicable NO_X+HC standards specified for Tier 2 engines in Appendix I of this part continue to apply instead of the values noted in the table for commercial engines at or above 2000 kW. FELs for these engines may not be higher than the Tier 1 NO_X standard specified in Appendix I of this part.

[c] See paragraph (a)(4) of this section for alternative PM and NO_X+HC standards for engines at or above 19 kW and below 75 kW with displacement below 0.9 L/cyl.

TABLE 2 TO § 1042.101—TIER 3 STANDARDS FOR CATEGORY 2 ENGINES BELOW 3700 kW [a]

Displacement (L/cyl)	Maximum engine power	Model year	PM (g/kW-hr)	NO_X+HC (g/kW-hr)
7.0 ≤ disp. ≤ 15.0	kW < 2000	2013+	0.14	6.2
	2000 ≤ kW ≤ 3700	2013+	0.14	[b] 7.8
15.0 ≤ disp. < 20.0 [c]	kW < 2000	2014+	0.34	7.0
20.0 ≤ disp. < 25.0 [c]	kW < 2000	2014+	0.27	9.8
25.0 ≤ disp. < 30.0 [c]	kW < 2000	2014+	0.27	11.0

[a] The Tier 3 standards in this table do not apply for Category 2 engines at or above 2000 kW with per-cylinder displacement at or above 15.0 liters, or for any Category 2 engines at or above 3700 kW. See § 1042.1(c) and paragraphs (a)(6) through (8) of this section for the standards that apply for these engines.

[b] For engines subject to the 7.8 g/kW-hr NO_X+HC standard, FELs may not be higher than the Tier 1 NO_X standards specified in Appendix I of this part.

[c] There are no Tier 3 standards for Category 2 engines with per-cylinder displacement at or above 15 and 20 liters with maximum engine power at or above 2000 kW. See paragraphs (a)(6) and (7) of this section for the Tier 4 standards that apply for these engines starting with the 2014 model year.

(4) For Tier 3 engines at or above 19 kW and below 75 kW with displacement below 0.9 L/cyl, you may alternatively certify some or all of your engine families to a PM emission standard of 0.20 g/kW-hr and a NO_X+HC emission standard of 5.8 g/kW-hr for 2014 and later model years.

(5) Starting with the 2014 model year, recreational marine engines at or above 3700 kW (with any displacement) must be certified under this part 1042 to the Tier 3 standards specified in this section for 3.5 to 7.0 L/cyl recreational marine engines.

(6) Interim Tier 4 PM standards apply for 2014 and 2015 model year engines between 2000 and 3700 kW as specified in this paragraph (a)(6). These engines are considered to be Tier 4 engines.

(i) For Category 1 engines, the Tier 3 PM standards from Table 1 to this section continue to apply. PM FELs for these engines may not be higher than the applicable Tier 2 PM standards specified in Appendix I of this part.

(ii) For Category 2 engines with per-cylinder displacement below 15.0 liters, the Tier 3 PM standards from Table 2 to this section continue to apply. PM FELs for these engines may not be higher than 0.27 g/kW-hr.

(iii) For Category 2 engines with per-cylinder displacement at or above 15.0 liters, the PM standard is 0.34 g/kW-hr for engines at or above 2000 kW and below 3300 kW, and 0.27 g/kW-hr for engines at or above 3300 kW and below 3700 kW. PM FELs for these engines may not be higher than 0.50 g/kW-hr.

(7) Except as described in paragraph (a)(8) of this section, the Tier 4 standards for PM, NO_X, and HC emissions are described in the following table:

TABLE 3 TO § 1042.101—TIER 4 STANDARDS FOR CATEGORY 2 AND COMMERCIAL CATEGORY 1 ENGINES AT OR ABOVE 600 kW

Maximum engine power	Displacement (L/cyl)	Model year	PM (g/kW-hr)	NO_X (g/kW-hr)	HC (g/kW-hr)
600 ≤kW <1400	all	2017+	0.04	1.8	0.19
1400 ≤kW <2000	all	2016+	0.04	1.8	0.19
2000 ≤kW ≤3700 [a]	all	2014+	0.04	1.8	0.19
kW >3700	disp. <15.0	2014–2015	0.12	1.8	0.19
	15.0 ≤ disp. <30.0	2014–2015	0.25	1.8	0.19

TABLE 3 TO § 1042.101—TIER 4 STANDARDS FOR CATEGORY 2 AND COMMERCIAL CATEGORY 1 ENGINES AT OR ABOVE 600 kW—Continued

Maximum engine power	Displacement (L/cyl)	Model year	PM (g/kW-hr)	NO_X (g/kW-hr)	HC (g/kW-hr)
	all	2016+	0.06	1.8	0.19

[a] See paragraph (a)(6) of this section for interim PM standards that apply for model years 2014 and 2015 for engines between 2000 and 3700 kW. The Tier 4 NO_X FEL cap for engines at or above 2000 kW and below 3700 kW is 7.0 g/kW-hr. Starting in the 2016 model year, the Tier 4 PM FEL cap for engines at or above 2000 kW and below 3700 kW is 0.34 g/kW-hr.

(8) The following optional provisions apply for complying with the Tier 3 and Tier 4 standards specified in paragraphs (a)(3) through (7) of this section:

(i) You may use NO_X credits accumulated through the ABT program to certify Tier 4 engines to a NO_X+HC emission standard of 1.9 g/kW-hr instead of the NO_X and HC standards that would otherwise apply by certifying your family to a NO_X+HC FEL. Calculate the NO_X credits needed as specified in subpart H of this part using the NO_X+HC emission standard and FEL in the calculation instead of the otherwise applicable NO_X standard and FEL. You may not generate credits relative to the alternate standard or certify to the standard without using credits.

(ii) For engines below 1000 kW, you may delay complying with the Tier 4 standards in the 2017 model year for up to nine months, but you must comply no later than October 1, 2017.

(iii) For engines at or above 3700 kW, you may delay complying with the Tier 4 standards in the 2016 model year for up to twelve months, but you must comply no later than December 31, 2016.

(iv) For Category 2 engines at or above 1400 kW, you may alternatively comply with the Tier 3 and Tier 4 standards specified in Table 4 of this section instead of the NO_X, HC, NO_X+HC, and PM standards specified in paragraphs (a)(3) through (7) of this section. The CO standards specified in paragraph (a)(2) of this section apply without regard to whether you choose this option. If you choose this option, you must do so for all engines at or above 1400 kW in the same displacement category (that is, 7–15, 15–20, 20–25, or 25–30 liters per cylinder) in model years 2012 through 2015.

TABLE 4 TO § 1042.101—OPTIONAL TIER 3 AND TIER 4 STANDARDS FOR CATEGORY 2 ENGINES AT OR ABOVE 1400 kW

Tier	Maximum engine power	Model year	PM (g/kW-hr)	NO_X (g/kW-hr)	HC (g/kW-hr)
Tier 3	kW >1400	2012–2014	0.14	7.8 NO_X+HC	
Tier 4	1400 ≤kW ≤3700	2015	0.04	1.8	0.19
	kW >3700	2015	0.06	1.8	0.19

(b) *Averaging, banking, and trading.* You may generate or use emission credits under the averaging, banking, and trading (ABT) program as described in subpart H of this part for demonstrating compliance with NO_X, NO_X+HC, and PM emission standards for Category 1 and Category 2 engines. You may also use NO_X or NO_X+HC emission credits to comply with the alternate NO_X+HC standard in paragraph (a)(8)(i) of this section. Generating or using emission credits requires that you specify a family emission limit (FEL) for each pollutant you include in the ABT program for each engine family. These FELs serve as the emission standards for the engine family with respect to all required testing instead of the standards specified in paragraph (a) of this section. The FELs determine the not-to-exceed standards for your engine family, as specified in paragraph (c) of this section. Unless otherwise specified, the following FEL caps apply:

(1) FELs for Tier 3 engines may not be higher than the applicable Tier 2 standards specified in Appendix I of this part.

(2) FELs for Tier 4 engines may not be higher than the applicable Tier 3 standards specified in paragraph (a)(3) of this section.

(3) The following FEL caps apply for engines at or above 3700 kW that are not subject to Tier 3 standards under paragraph (a)(3) of this section:

(i) FELs may not be higher than the applicable Tier 1 NO_X standards specified in Appendix I of this part before the Tier 4 standards start to apply.

(ii) FELs may not be higher than the applicable Tier 2 NO_X+THC standards specified in Appendix I of this part after the Tier 4 standards start to apply.

(c) *Not-to-exceed standards.* Except as noted in § 1042.145(e), exhaust emissions from all engines subject to the requirements of this part may not exceed the not-to-exceed (NTE) standards as follows:

(1) Use the following equation to determine the NTE standards:

(i) NTE standard for each pollutant = STD × M.

Where:

STD = The standard specified for that pollutant in this section if you certify without using ABT for that pollutant; or the FEL for that pollutant if you certify using ABT.

M = The NTE multiplier for that pollutant.

(ii) Round each NTE standard to the same number of decimal places as the emission standard.

(2) Determine the applicable NTE zone and subzones as described in § 1042.515. Determine NTE multipliers for specific zones and subzones and pollutants as follows:

(i) For marine engines certified using the duty cycle specified in § 1042.505(b)(1), except for variable-speed propulsion marine engines used with controllable-pitch propellers or with electrically coupled propellers, apply the following NTE multipliers:

(A) Subzone 1: 1.2 for Tier 3 NO_X+HC standards.

(B) Subzone 1: 1.5 for Tier 4 standards and Tier 3 p.m. and CO standards.

(C) Subzone 2: 1.5 for Tier 4 NO_X and HC standards and for Tier 3 NO_X+HC standards.

(D) Subzone 2: 1.9 for PM and CO standards.

(ii) For recreational marine engines certified using the duty cycle specified in § 1042.505(b)(2), except for variable-speed marine engines used with controllable-pitch propellers or with electrically coupled propellers, apply the following NTE multipliers:

(A) Subzone 1: 1.2 for Tier 3 NO_X+HC standards.

(B) Subzone 1: 1.5 for Tier 3 p.m. and CO standards.

(C) Subzones 2 and 3: 1.5 for Tier 3 NO_X+HC standards.

(D) Subzones 2 and 3: 1.9 for PM and CO standards.

(iii) For variable-speed marine engines used with controllable-pitch propellers or with electrically coupled propellers that are certified using the duty cycle specified in § 1042.505(b)(1), (2), or (3), apply the following NTE multipliers:

(A) Subzone 1: 1.2 for Tier 3 NO_X+HC standards.

(B) Subzone 1: 1.5 for Tier 4 standards and Tier 3 p.m. and CO standards.

(C) Subzone 2: 1.5 for Tier 4 NO_X and HC standards and for Tier 3 NO_X+HC standards.

(D) Subzone 2: 1.9 for PM and CO standards. However, there is no NTE standard in Subzone 2b for PM emissions if the engine family's applicable standard for PM is at or above 0.07 g/kW-hr.

(iv) For constant-speed engines certified using a duty cycle specified in § 1042.505(b)(3) or (4), apply the following NTE multipliers:

(A) Subzone 1: 1.2 for Tier 3 NO_X+HC standards.

(B) Subzone 1: 1.5 for Tier 4 standards and Tier 3 p.m. and CO standards.

(C) Subzone 2: 1.5 for Tier 4 NO_X and HC standards and for Tier 3 NO_X+HC standards.

(D) Subzone 2: 1.9 for PM and CO standards. However, there is no NTE standard for PM emissions if the engine family's applicable standard for PM is at or above 0.07 g/kW-hr.

(v) For variable-speed auxiliary marine engines certified using the duty cycle specified in § 1042.505(b)(5)(ii) or (iii):

(A) Subzone 1: 1.2 for Tier 3 NO_X+HC standards.

(B) Subzone 1: 1.5 for Tier 4 standards and Tier 3 p.m. and CO standards.

(C) Subzone 2: 1.2 for Tier 3 NO_X+HC standards.

(D) Subzone 2: 1.5 for Tier 4 standards and Tier 3 p.m. and CO standards. However, there is no NTE standard for PM emissions if the engine family's applicable standard for PM is at or above 0.07 g/kW-hr.

(3) The NTE standards apply to your engines whenever they operate within the NTE zone for an NTE sampling period of at least thirty seconds, during which only a single operator demand set point may be selected. Engine operation during a change in operator demand is excluded from any NTE sampling period. There is no maximum NTE sampling period.

(4) Collect emission data for determining compliance with the NTE standards using the procedures described in subpart F of this part.

(5) You may ask us to accept as compliant an engine that does not fully meet specific requirements under the applicable NTE standards where such deficiencies are necessary for safety.

* * * * *

■ 161. Section 1042.104 is amended by revising paragraph (a)(2) to read as follows:

§ 1042.104 Exhaust emission standards for Category 3 engines.

(a) * * *

(2) NO_X standards apply based on the engine's model year and maximum in-use engine speed as shown in the following table:

TABLE 1 TO § 1042.104—NO_X EMISSION STANDARDS FOR CATEGORY 3 ENGINES

[g/kW-hr]

Emission standards	Model year	Maximum in-use engine speed		
		Less than 130 RPM	130–2000 RPM [a]	Over 2000 RPM
Tier 1	2004–2010 [b]	17.0	$45.0 \cdot n^{(-0.20)}$	9.8
Tier 2	2011–2015	14.4	$44.0 \cdot n^{(-0.23)}$	7.7
Tier 3 [c]	2016 and later	3.4	$9.0 \cdot n^{(-0.20)}$	2.0

[a] Applicable standards are calculated from n (maximum in-use engine speed, in RPM, as specified in § 1042.140). Round the standards to one decimal place.

[b] Tier 1 NO_X standards apply as specified in 40 CFR part 94 for engines originally manufactured in model years 2004 through 2010. They are shown here only for reference.

[c] For engines designed with on-off controls as specified in § 1042.115(g), the Tier 2 standards continue to apply anytime the engine has disabled its Tier 3 NO_X emission controls.

* * * * *

■ 162. Section 1042.110 is amended by removing and reserving paragraph (b) and revising paragraph (d).

The revision reads as follows:

§ 1042.110 Recording reductant use and other diagnostic functions.

* * * * *

(d) For Category 3 engines equipped with on-off NO_X controls (as allowed by § 1042.115(g)), you must also equip your engine to continuously monitor NO_X concentrations in the exhaust. See § 1042.650 to determine if this requirement applies for a given Category 1 or Category 2 engine. For measurement technologies involving discrete sampling events, measurements are considered continuous if they repeat at least once every 60 seconds; we may approve a longer sampling period if it is necessary or appropriate for sufficiently accurate measurements. Describe your system for onboard NO_X measurements in your application for certification. Use good engineering judgment to alert operators if measured NO_X concentrations indicate malfunctioning emission controls. Record any such operation in nonvolatile computer memory. You are not required to monitor NO_X concentrations during operation for which the emission controls may be disabled under § 1042.115(g). For the purpose of this paragraph (d), ''malfunctioning emission controls'' means any condition in which the measured NO_X concentration exceeds the highest value expected when the engine is in compliance with the installed engine standard of § 1042.104(g). Use good engineering judgment to determine these expected values during production-line testing of the engine using linear interpolation between test points and accounting for the degree to which the cycle-weighted emissions of the engine are below the standard. You may also use additional intermediate test points measured during the production-line test. Note that the provisions of paragraph (a) of this section also apply for SCR systems covered by this paragraph (d). For engines subject to both the provisions of paragraph (a) of this section and this paragraph (d), use good engineering judgment to integrate diagnostic features to comply with both paragraphs. For example, engines may use on-off NO_X controls to disable certain emission control functions only if the diagnostic system indicates that the monitoring described in this paragraph (d) is active.

■ 163. Section 1042.120 is amended by revising paragraph (b) introductory text to read as follows:

§ 1042.120 Emission-related warranty requirements.

* * * * *

(b) *Warranty period.* Your emission-related warranty must be valid for at least as long as the minimum warranty periods listed in this paragraph (b) in hours of operation and years, whichever comes first. You may offer an emission-related warranty more generous than we require. The emission-related warranty for the engine may not be shorter than any basic mechanical warranty you provide without charge for the engine. Similarly, the emission-related warranty for any component may not be shorter than any warranty you provide without charge for that component. This means that your warranty may not treat emission-related and nonemission-related defects differently for any component. If an engine has no hour meter, we base the warranty periods in this paragraph (b) only on the engine's age (in years). The warranty period begins when the engine is placed into service. The following minimum warranty periods apply:

* * * * *

■ 164. Section 1042.125 is amended by revising paragraphs (a)(2)(i), (a)(3)(i), (c), and (e) to read as follows:

§ 1042.125 Maintenance instructions.

* * * * *

(a) * * *

(2) * * *

(i) For EGR-related filters and coolers, DEF filters, PCV valves, and fuel injector tips (cleaning only), the minimum interval is 1,500 hours.

* * * * *

(3) * * *

(i) For EGR-related filters and coolers, DEF filters, PCV valves, and fuel injector tips (cleaning only), the minimum interval is 1,500 hours.

* * * * *

(c) *Special maintenance.* You may specify more frequent maintenance to address problems related to special situations, such as atypical engine operation. You must clearly state that this additional maintenance is associated with the special situation you are addressing. You may also address maintenance of low-use engines (such as recreational or stand-by engines) by specifying the maintenance interval in terms of calendar months or years in addition to your specifications in terms of engine operating hours. All special maintenance instructions must be consistent with good engineering judgment. We may disapprove your maintenance instructions if we determine that you have specified special maintenance steps to address maintenance that is unlikely to occur in use, or engine operation that is not atypical. For example, this paragraph (c) does not allow you to design engines that require special maintenance for a certain type of expected operation. If we determine that certain maintenance items do not qualify as special maintenance under this paragraph (c), you may identify this as recommended additional maintenance under paragraph (b) of this section.

* * * * *

(e) *Maintenance that is not emission-related.* For maintenance unrelated to emission controls, you may schedule any amount of inspection or maintenance. You may also take these inspection or maintenance steps during service accumulation on your emission-data engines, as long as they are reasonable and technologically necessary. This might include adding engine oil, changing air, fuel, or oil filters, servicing engine-cooling systems, and adjusting idle speed, governor, engine bolt torque, valve lash, or injector lash. You may not perform this nonemission-related maintenance on emission-data engines more often than the least frequent intervals that you recommend to the ultimate purchaser.

* * * * *

■ 165. Section 1042.130 is amended by revising paragraph (b) to read as follows:

§ 1042.130 Installation instructions for vessel manufacturers.

* * * * *

(b) Make sure these instructions have the following information:

(1) Include the heading: ''Emission-related installation instructions''.

(2) State: ''Failing to follow these instructions when installing a certified engine in a vessel violates federal law (40 CFR 1068.105(b)), subject to fines or other penalties as described in the Clean Air Act.''

(3) Describe the instructions needed to properly install the exhaust system and any other components. Include instructions consistent with the requirements of § 1042.205(u).

(4) Describe any necessary steps for installing the diagnostic system described in § 1042.110.

(5) Describe how your certification is limited for any type of application. . For example, if your engines are certified only for constant-speed operation, tell vessel manufacturers not to install the engines in variable-speed applications or modify the governor.

(6) Describe any other instructions to make sure the installed engine will operate according to design specifications in your application for certification. This may include, for example, instructions for installing aftertreatment devices when installing the engines.

(7) State: ''If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the vessel, as described in 40 CFR 1068.105.''

(8) Describe any vessel labeling requirements specified in § 1042.135.

* * * * *

■ 166. Section 1042.135 is amended by revising paragraphs (c), (d)(1), and (e) introductory text to read as follows:

§ 1042.135 Labeling.

* * * * *

(c) The label must—

(1) Include the heading ''EMISSION CONTROL INFORMATION''.

(2) Include your full corporate name and trademark. You may identify another company and use its trademark instead of yours if you comply with the branding provisions of 40 CFR 1068.45.

(3) Include EPA's standardized designation for the engine family (and subfamily, where applicable).

(4) Identify all the emission standards that apply to the engine (or FELs, if applicable). If you do not declare an FEL under subpart H of this part, you may alternatively state the engine's category, displacement (in liters or L/cyl), maximum engine power (in kW), and power density (in kW/L) as needed to determine the emission standards for the engine family. You may specify displacement, maximum engine power, or power density as a range consistent with the ranges listed in § 1042.101. See § 1042.140 for descriptions of how to specify per-cylinder displacement, maximum engine power, and power density.

(5) State the date of manufacture [DAY (optional), MONTH, and YEAR]; however, you may omit this from the label if you stamp, engrave, or otherwise

permanently identify it elsewhere on the engine, in which case you must also describe in your application for certification where you will identify the date on the engine.

(6) Identify the application(s) for which the engine family is certified (such as constant-speed auxiliary, variable-speed propulsion engines used with fixed-pitch propellers, etc.). If the engine is certified as a recreational engine, state: ''INSTALLING THIS RECREATIONAL ENGINE IN A COMMERCIAL VESSEL OR USING THE VESSEL FOR COMMERCIAL PURPOSES MAY VIOLATE FEDERAL LAW SUBJECT TO CIVIL PENALTY (40 CFR 1042.601).''

(7) For engines using sulfur-sensitive technologies, state: ''ULTRA LOW SULFUR DIESEL FUEL ONLY''.

(8) State the useful life for your engine family if the applicable useful life is based on the provisions of § 1042.101(e)(2) or (3), or § 1042.104(d)(2).

(9) Identify the emission control system. Use terms and abbreviations as described in 40 CFR 1068.45. You may omit this information from the label if there is not enough room for it and you put it in the owners manual instead.

(10) State: ''THIS MARINE ENGINE COMPLIES WITH U.S. EPA REGULATIONS FOR [MODEL YEAR].''

(11) For a Category 1 or Category 2 engine that can be modified to operate on residual fuel, but has not been certified to meet the standards on such a fuel, include the statement: ''THIS ENGINE IS CERTIFIED FOR OPERATION ONLY WITH DIESEL FUEL. MODIFYING THE ENGINE TO OPERATE ON RESIDUAL OR INTERMEDIATE FUEL MAY BE A VIOLATION OF FEDERAL LAW SUBJECT TO CIVIL PENALTIES.''

(12) For an engine equipped with on-off emissions controls as allowed by § 1042.115, include the statement: ''THIS ENGINE IS CERTIFIED WITH ON–OFF EMISSION CONTROLS. OPERATION OF THE ENGINE CONTRARY TO 40 CFR 1042.115(g) IS A VIOLATION OF FEDERAL LAW SUBJECT TO CIVIL PENALTIES.''

(13) For engines intended for installation on domestic or public vessels, include the following statement: ''THIS ENGINE DOES NOT COMPLY WITH INTERNATIONAL MARINE REGULATIONS FOR COMMERCIAL VESSELS UNLESS IT IS ALSO COVERED BY AN EIAPP CERTIFICATE.''

(d) * * *

(1) If your emission control information label includes all the information described in paragraphs (c)(5) and (9) of this section, you may identify other emission standards that the engine meets or does not meet (such as international standards). You may include this information by adding it to the statement we specify or by including a separate statement.

* * * * *

(e) For engines using sulfur-sensitive technologies, create a separate label with the statement: ''ULTRA LOW SULFUR DIESEL FUEL ONLY''. Permanently attach this label to the vessel near the fuel inlet or, if you do not manufacture the vessel, take one of the following steps to ensure that the vessel will be properly labeled:

* * * * *

■ 167. Section 1042.140 is amended by revising paragraph (e) to read as follows:

§ 1042.140 Maximum engine power, displacement, power density, and maximum in-use engine speed.

* * * * *

(e) Throughout this part, references to a specific power value for an engine are based on maximum engine power. For example, the group of engines with maximum engine power below 600 kW may be referred to as engines below 600 kW.

* * * * *

Subpart C—Certifying Engine Families

■ 168. Section 1042.201 is amended by revising paragraphs (a) and (g) to read as follows:

§ 1042.201 General requirements for obtaining a certificate of conformity.

(a) You must send us a separate application for a certificate of conformity for each engine family. A certificate of conformity is valid for new production from the indicated effective date until the end of the model year for which it is issued, which may not extend beyond December 31 of that year. No certificate will be issued after December 31 of the model year. You may amend your application for certification after the end of the model year in certain circumstances as described in §§ 1042.220 and 1042.225. You must renew your certification annually for any engines you continue to produce.

* * * * *

(g) We may require you to deliver your test engines to a facility we designate for our testing (see § 1042.235(c)). Alternatively, you may choose to deliver another engine that is identical in all material respects to the test engine, or another engine that we determine can appropriately serve as an emission-data engine for the engine family.

* * * * *

■ 169. Section 1042.205 is amended by revising paragraphs (g), (o), (r)(1), and (bb)(1) to read as follows:

§ 1042.205 Application requirements.

* * * * *

(g) List the specifications of the test fuel(s) to show that they fall within the required ranges we specify in 40 CFR part 1065.

* * * * *

(o) Present emission data for HC, NO_X, PM, and CO on an emission-data engine to show your engines meet emission standards as specified in §§ 1042.101 or 1042.104. Note that you must submit PM data for all engines, whether or not a PM standard applies. Show emission figures before and after applying adjustment factors for regeneration and deterioration factors for each pollutant and for each engine. If we specify more than one grade of any fuel type (for example, high-sulfur and low-sulfur diesel fuel), you need to submit test data only for one grade, unless the regulations of this part specify otherwise for your engine. Include emission results for each mode for Category 3 engines or for other engines if you do discrete-mode testing under § 1042.505. For engines using on-off controls as described in § 1042.115(g), include emission data demonstrating compliance with the Tier 2 standards when the engines Tier 3 NOx emission controls are disabled. Note that §§ 1042.235 and 1042.245 allows you to submit an application in certain cases without new emission data.

* * * * *

(r) * * *

(1) Report all valid test results involving measurement of pollutants for which emission standards apply. Also indicate whether there are test results from invalid tests or from any other tests of the emission-data engine, whether or not they were conducted according to the test procedures of subpart F of this part. We may require you to report these additional test results. We may ask you to send other information to confirm that your tests were valid under the requirements of this part and 40 CFR part 1065.

* * * * *

(bb) * * *

(1) Describe your normal practice for importing engines. For example, this may include identifying the names and addresses of any agents you have authorized to import your engines.

* * * * *

■ 170. Section 1042.225 is amended by revising the introductory text and adding paragraph (b)(4) to read as follows:

§ 1042.225 Amending applications for certification.

Before we issue you a certificate of conformity, you may amend your application to include new or modified engine configurations, subject to the provisions of this section. After we have issued your certificate of conformity, but before the end of the model year, you may send us an amended application requesting that we include new or modified engine configurations within the scope of the certificate, subject to the provisions of this section. Before the end of the model year, you must amend your application if any changes occur with respect to any information that is included or should be included in your application. After the end of the model year, you may amend your application only to update maintenance instructions as described in § 1042.220 or to modify an FEL as described in paragraph (f) of this section.

* * * * *

(b) * * *

(4) Include any other information needed to make your application correct and complete.

* * * * *

■ 171. Section 1042.235 is amended by revising paragraphs (b), (c)(4), and (d)(1) to read as follows:

§ 1042.235 Emission testing related to certification.

* * * * *

(b) Test your emission-data engines using the procedures and equipment specified in subpart F of this part. In the case of dual-fuel engines, measure emissions when operating with each type of fuel for which you intend to certify the engine. In the case of flexible-fuel engines, measure emissions when operating with the fuel mixture that best represents in-use operation or is most likely to have the highest NO_X emissions (or NO_X+HC emissions for engines subject to NO_X+HC standards), though you may ask us to instead to perform tests with both fuels separately if you can show that intermediate mixtures are not likely to occur in use.

* * * * *

(c) * * *

(4) Before we test one of your engines, we may calibrate it within normal production tolerances for anything we do not consider an adjustable parameter. For example, this would apply for an engine parameter that is subject to production variability because it is adjustable during production, but is not considered an adjustable parameter (as defined in § 1042.901) because it is permanently sealed. For parameters that relate to a level of performance that is itself subject to a specified range (such as maximum power output), we will generally perform any calibration under this paragraph (c)(4) in a way that keeps performance within the specified range.

(d) * * *

(1) The engine family from the previous model year differs from the current engine family only with respect to model year, items identified in § 1042.225(a), or other characteristics unrelated to emissions. We may waive this criterion for differences we determine not to be relevant.

* * * * *

■ 172. Section 1042.240 is amended by revising paragraph (c)(3), adding paragraphs (c)(4) and (5), and revising paragraph (d) to read as follows:

§ 1042.240 Demonstrating compliance with exhaust emission standards.

* * * * *

(c) * * *

(3) *Sawtooth deterioration patterns.* The deterioration factors described in paragraphs (c)(1) and (2) of this section assume that the highest useful life emissions occur either at the end of useful life or at the low-hour test point. The provisions of this paragraph (c)(3) apply where good engineering judgment indicates that the highest emissions over the useful life will occur between these two points. For example, emissions may increase with service accumulation until a certain maintenance step is performed, then return to the low-hour emission levels and begin increasing again. Base deterioration factors for engines with such emission patterns on the difference between (or ratio of) the point of the sawtooth at which the highest emissions occur and the low-hour test point. Note that this applies for maintenance-related deterioration only where we allow such critical emission-related maintenance.

(4) *Deterioration factor for crankcase emissions.* If your engine vents crankcase emissions to the exhaust or to the atmosphere, you must account for crankcase emission deterioration, using good engineering judgment. You may use separate deterioration factors for crankcase emissions of each pollutant (either multiplicative or additive) or include the effects in combined deterioration factors that include exhaust and crankcase emissions together for each pollutant.

(5) *Dual-fuel and flexible-fuel engines.* In the case of dual-fuel and flexible-fuel engines, apply deterioration factors separately for each fuel type. You may accumulate service hours on a single emission-data engine using the type of fuel or the fuel mixture expected to have the highest combustion and exhaust temperatures; you may ask us to approve a different fuel mixture if you demonstrate that a different criterion is more appropriate.

(d) Determine the official emission result for each pollutant to at least one more decimal place than the applicable standard. Apply the deterioration factor to the official emission result, as described in paragraph (c) of this section, then round the adjusted figure to the same number of decimal places as the emission standard. Compare the rounded emission levels to the emission standard for each emission-data engine. In the case of NO_X+HC standards, apply the deterioration factor to each pollutant and then add the results before rounding.

* * * * *

■ 173. Section 1042.250 is amended by revising paragraphs (b)(3)(iv) and (c) to read as follows:

§ 1042.250 Recordkeeping and reporting.

* * * * *

(b) * * *

(3) * * *

(iv) All your emission tests, including the date and purpose of each test and documentation of test parameters as specified in part 40 CFR part 1065.

* * * * *

(c) Keep required data from emission tests and all other information specified in this section for eight years after we issue your certificate. If you use the same emission data or other information for a later model year, the eight-year period restarts with each year that you continue to rely on the information.

* * * * *

■ 174. Section 1042.255 is amended by revising paragraphs (c)(2), (d), and (e) to read as follows:

§ 1042.255 EPA decisions.

* * * * *

(c) * * *

(2) Submit false or incomplete information (paragraph (e) of this section applies if this is fraudulent). This includes doing anything after submission of your application to render any of the submitted information false or incomplete.

* * * * *

(d) We may void the certificate of conformity for an engine family if you fail to keep records, send reports, or give us information as required under this part or the Clean Air Act. Note that these are also violations of 40 CFR 1068.101(a)(2).

(e) We may void your certificate if we find that you intentionally submitted false or incomplete information. This includes rendering submitted information false or incomplete after submission.

* * * * *

Subpart D—Testing Production-Line Engines

■ 175. Section 1042.302 is amended by revising paragraph (a) to read as follows:

§ 1042.302 Applicability of this subpart for Category 3 engines.

* * * * *

(a) You must test each Category 3 engine at the sea trial of the vessel in which it is installed or within the first 300 hours of operation, whichever occurs first. This may involve testing a fully assembled production engine before it is installed in the vessel. Since you must test each engine, the provisions of §§ 1042.310 and 1042.315(b) do not apply for Category 3 engines. If we determine that an engine failure under this subpart is caused by defective components or design deficiencies, we may revoke or suspend your certificate for the engine family as described in § 1042.340. If we determine that an engine failure under this subpart is caused only by incorrect assembly, we may suspend your certificate for the engine family as described in § 1042.325. If the engine fails, you may continue operating only to complete the sea trial and return to port. It is a violation of 40 CFR 1068.101(b)(1) to operate the vessel further until you remedy the cause of failure. Each two-hour period of such operation constitutes a separate offense. A violation lasting less than two hours constitutes a single offense.

* * * * *

Subpart F—Test Procedures

■ 176. Section 1042.501 is amended by revising paragraphs (d), (e), and (f) and adding paragraph (h) to read as follows:

§ 1042.501 How do I run a valid emission test?

* * * * *

(d) Adjust measured emissions to account for aftertreatment technology with infrequent regeneration as described in § 1042.525.

(e) Duty-cycle testing is limited to atmospheric pressures between 91.000 and 103.325 kPa.

(f) You may use special or alternate procedures to the extent we allow them under 40 CFR 1065.10.

* * * * *

(h) This subpart is addressed to you as a manufacturer, but it applies equally to anyone who does testing for you, and to us when we perform testing to determine if your engines meet emission standards.

■ 177. Section 1042.505 is amended by revising paragraph (b)(5)(iii) to read as follows:

§ 1042.505 Testing engines using discrete-mode or ramped-modal duty cycles.

* * * * *

(b) * * *

(5) * * *

(iii) Use the 8-mode duty cycle or the corresponding ramped-modal cycle described in 40 CFR part 1039, Appendix II, paragraph (c) for variable-speed auxiliary engines with maximum engine power at or above 19 kW that are not propeller-law engines.

* * * * *

■ 178. Section 1042.515 is amended by revising paragraphs (f)(2), (f)(4), and (g) to read as follows:

§ 1042.515 Test procedures related to not-to-exceed standards.

* * * * *

(f) * * *

(2) You may ask us to approve a Limited Testing Region (LTR). An LTR is a region of engine operation, within the applicable NTE zone, where you have demonstrated that your engine family operates for no more than 5.0 percent of its normal in-use operation, on a time-weighted basis. You must specify an LTR using boundaries based on engine speed and power (or torque), where the LTR boundaries must coincide with some portion of the boundary defining the overall NTE zone. Any emission data collected within an LTR for a time duration that exceeds 5.0 percent of the duration of its respective NTE sampling period will be excluded when determining compliance with the applicable NTE standards. Any emission data collected within an LTR for a time duration of 5.0 percent or less of the duration of the respective NTE sampling period will be included when determining compliance with the NTE standards.

* * * * *

(4) You may exclude emission data based on catalytic aftertreatment temperatures as follows:

(i) For an engine equipped with a catalytic NO_X aftertreatment system, exclude NO_X emission data that is collected when the exhaust temperature at any time during the NTE event is less than 250 °C.

(ii) For an engine equipped with an oxidizing catalytic aftertreatment system, exclude HC and CO emission data that is collected when the exhaust temperature at any time during the NTE event is less than 250 °C. Also exclude PM emission data if the applicable PM standard (or family emission limit) is above 0.06 g/kW-hr. Where there are parallel paths, measure the temperature 30 cm downstream of the last oxidizing aftertreatment device in the path with the greatest exhaust flow.

(iii) Measure exhaust temperature within 30 cm downstream of the last applicable catalytic aftertreatment device. Where there are parallel paths, use good engineering judgment to measure the temperature within 30 cm downstream of the last applicable catalytic aftertreatment device in the path with the greatest exhaust flow.

(g) Emission sampling is not valid for NTE testing if it includes any active regeneration, unless the emission averaging period includes the complete regeneration event(s) and the full period of engine operation until the start of the next regeneration event. This provision applies only for engines that send an electronic signal indicating the start of the regeneration event.

■ 179. Section 1042.525 is revised to read as follows:

§ 1042.525 How do I adjust emission levels to account for infrequently regenerating aftertreatment devices?

For engines using aftertreatment technology with infrequent regeneration events that may occur during testing, take one of the following approaches to account for the emission impact of regeneration, or use an alternate methodology that we approve for Category 3 engines:

(a) You may use the calculation methodology described in 40 CFR 1065.680 to adjust measured emission results. Do this by developing an upward adjustment factor and a downward adjustment factor for each pollutant based on measured emission data and observed regeneration frequency as follows:

(1) Adjustment factors should generally apply to an entire engine family, but you may develop separate adjustment factors for different configurations within an engine family. Use the adjustment factors from this section in all testing for the engine family.

(2) You may use carryover or carry-across data to establish adjustment factors for an engine family as described in § 1042.235, consistent with good engineering judgment.

(3) Determine the frequency of regeneration, *F*, as described in 40 CFR 1065.680 from in-use operating data or from running repetitive tests in a

laboratory. If the engine is designed for regeneration at fixed time intervals, you may apply good engineering judgment to determine *F* based on those design parameters.

(4) Identify the value of *F* in each application for certification for which it applies.

(b) You may ask us to approve an alternate methodology to account for regeneration events. We will generally limit approval to cases where your engines use aftertreatment technology with extremely infrequent regeneration and you are unable to apply the provisions of this section.

(c) You may choose to make no adjustments to measured emission results if you determine that regeneration does not significantly affect emission levels for an engine family (or configuration) or if it is not practical to identify when regeneration occurs. If you choose not to make adjustments under paragraph (a) or (b) of this section, your engines must meet emission standards for all testing, without regard to regeneration.

Subpart G—Special Compliance Provisions

■ 180. Section 1042.601 is amended by adding paragraph (j) to read as follows:

§ 1042.601 General compliance provisions for marine engines and vessels.

* * * * *

(j) Subpart C of this part describes how to test and certify dual-fuel and flexible-fuel engines. Some multi-fuel engines may not fit either of those defined terms. For such engines, we will determine whether it is most appropriate to treat them as single-fuel engines, dual-fuel engines, or flexible-fuel engines based on the range of possible and expected fuel mixtures. For example, an engine might burn natural gas but initiate combustion with a pilot injection of diesel fuel. If the engine is designed to operate with a single fueling algorithm (*i.e.,* fueling rates are fixed at a given engine speed and load condition), we would generally treat it as a single-fuel engine, In this context, the combination of diesel fuel and natural gas would be its own fuel type. If the engine is designed to also operate on diesel fuel alone, we would generally treat it as a dual-fueled engine. If the engine is designed to operate on varying mixtures of the two fuels, we would generally treat it as a flexible-fueled engine. To the extent that requirements vary for the different fuels or fuel mixtures, we may apply the more stringent requirements.

■ 181. Section 1042.605 is amended by revising paragraphs (e)(3) to read as follows:

§ 1042.605 Dressing engines already certified to other standards for nonroad or heavy-duty highway engines for marine use.

* * * * *

(e) * * *

(3) Send the Designated Compliance Officer written notification describing your plans before using the provisions of this section. In addition, by February 28 of each calendar year (or less often if we tell you), send the Designated Compliance Officer a signed letter with all the following information:

(i) Identify your full corporate name, address, and telephone number.

(ii) List the engine models for which you used this exemption in the previous year and describe your basis for meeting the sales restrictions of paragraph (d)(4) of this section.

(iii) State: ''We prepared each listed engine model for marine application without making any changes that could increase its certified emission levels, as described in 40 CFR 1042.605.''

* * * * *

■ 182. Section 1042.610 is amended by revising paragraph (e)(2) to read as follows:

§ 1042.610 Certifying auxiliary marine engines to land-based standards.

* * * * *

(e) * * *

(2) Send the Designated Compliance Officer written notification describing your plans before using the provisions of this section. In addition, by February 28 of each calendar year (or less often if we tell you), send the Designated Compliance Officer a signed letter with all the following information:

(i) Identify your full corporate name, address, and telephone number.

(ii) List the engine models for which you used this exemption in the previous year and describe your basis for meeting the sales restrictions of paragraph (d)(3) of this section.

(iii) State: ''We prepared each listed engine model for marine application without making any changes that could increase its certified emission levels, as described in 40 CFR 1042.610.''

* * * * *

■ 183. Section 1042.630 is amended by revising paragraph (f) to read as follows:

§ 1042.630 Personal-use exemption.

* * * * *

(f) The vessel must be a vessel that is not classed or subject to Coast Guard inspections or surveys. Note that dockside examinations performed by the Coast Guard are not considered inspections (see 46 U.S.C. 3301 and 46 U.S.C. 4502).

§ 1042.640 [Removed]

■ 184. Section 1042.640 is removed.

■ 185. Section 1042.650 is amended by revising paragraphs (a) and (d) to read as follows:

§ 1042.650 Migratory vessels.

* * * * *

(a) *Temporary exemption.* A vessel owner may ask us for a temporary exemption from the tampering prohibition in 40 CFR 1068.101(b)(1) for a vessel if it will operate for an extended period outside the United States where ULSD is not available. In your request, describe where the vessel will operate, how long it will operate there, why ULSD will be unavailable, and how you will modify the engine, including its emission controls. If we approve your request, you may modify the engine, but only as needed to disable or remove the emission controls needed for meeting the Tier 4 standards. You must return the engine to its original certified configuration before the vessel returns to the United States to avoid violating the tampering prohibition in 40 CFR 1068.101(b)(1). We may set additional conditions to prevent circumvention of the provisions of this part.

* * * * *

(d) *Auxiliary engines on Category 3 vessels.* Auxiliary engines that will be installed on vessels with Category 3 propulsion engines qualify for an exemption from the standards of this part provided all the following conditions are met:

(1) To be eligible for this exemption, the engine must meet all of the following criteria.

(i) The engine must be certified to the applicable NO_X standards of Annex VI and meet all other applicable requirements of 40 CFR part 1043. Engines installed on vessels constructed on or after January 1, 2016 must conform fully to the Annex VI Tier III NO_X standards as described in 40 CFR part 1043 and meet all other applicable requirements in 40 CFR part 1043. Engines that would otherwise be subject to the Tier 4 standards of this part must also conform fully to the Annex VI Tier III NO_X standards as described in 40 CFR part 1043.

(ii) The engine may not be used for propulsion (except for emergency engines).

(iii) Engines certified to the Annex VI Tier III standards may be equipped with on-off NO_X controls, as long as they conform to the requirements of §§ 1042.110(d) and 1042.115(g);

however, the engines must comply fully with the Annex VI Tier II standards when the emission controls are disabled, and meet any other requirements that apply under Annex VI.

(2) You must notify the Designated Compliance Officer of your intent to use this exemption before you introduce engines into U.S. commerce, not later than the time that you apply for an EIAPP certificate for the engine under 40 CFR part 1043.

(3) The remanufactured engine requirements of subpart I of this part do not apply.

(4) If you introduce an engine into U.S. commerce under this paragraph (d), you must meet the labeling requirements in § 1042.135, but add the following statement instead of the compliance statement in § 1042.135(c)(10):

THIS ENGINE DOES NOT COMPLY WITH CURRENT U.S. EPA EMISSION STANDARDS UNDER 40 CFR 1042.650 AND IS FOR USE SOLELY IN VESSELS WITH CATEGORY 3 PROPULSION ENGINES. INSTALLATION OR USE OF THIS ENGINE IN ANY OTHER APPLICATION MAY BE A VIOLATION OF FEDERAL LAW SUBJECT TO CIVIL PENALTY.

(5) The reporting requirements of § 1042.660 apply for engines exempted under this paragraph (d).

■ 186. Section 1042.655 is amended by revising the section heading and paragraph (b) to read as follows:

§ 1042.655 Special certification provisions for Category 3 engines with aftertreatment.

* * * * *

(b) *Required testing.* The emission-data engine must be tested as specified in subpart F of this part to verify that the engine-out emissions comply with the Tier 2 standards. The catalyst material or other aftertreatment device must be tested under conditions that accurately represent actual engine conditions for the test points. This catalyst or aftertreatment testing may be performed on a benchscale.

* * * * *

■ 187. Section 1042.660 is amended by revising paragraphs (b) and (c)(1) to read as follows:

§ 1042.660 Requirements for vessel manufacturers, owners, and operators.

* * * * *

(b) For vessels equipped with SCR systems requiring the use of urea or other reductants, owners and operators must report to the Designated Enforcement Officer within 30 days any operation of such vessels without the appropriate reductant. This includes vessels with auxiliary engines certified to Annex VI standards under § 1042.650(d). Failure to comply with the requirements of this paragraph is a violation of 40 CFR 1068.101(a)(2). Note that such operation is a violation of 40 CFR 1068.101(b)(1).

(c) * * *

(1) The requirements of this paragraph (c)(1) apply only for Category 3 engines. All maintenance, repair, adjustment, and alteration of Category 3 engines subject to the provisions of this part performed by any owner, operator or other maintenance provider must be performed using good engineering judgment, in such a manner that the engine continues (after the maintenance, repair, adjustment or alteration) to meet the emission standards it was certified as meeting prior to the need for service. This includes but is not limited to complying with the maintenance instructions described in § 1042.125. Adjustments are limited to the range specified by the engine manufacturer in the approved application for certification. Note that where a repair (or other maintenance) cannot be completed while at sea, it is not a violation to continue operating the engine to reach your destination.

* * * * *

■ 188. Section 1042.670 is amended by revising paragraph (d) to read as follows:

§ 1042.670 Special provisions for gas turbine engines.

* * * * *

(d) *Equivalent displacement.* Apply displacement-based provisions of this part by calculating an equivalent displacement from maximum engine power. The equivalent per-cylinder displacement (in liters) equals maximum engine power in kW multiplied by 0.00311, except that all gas turbines with maximum engine power above 9,300 kW are considered to have an equivalent per-cylinder displacement of 29.0 liters. Also, determine the appropriate Tier 3 standards for Category 1 engines based on the engine having an equivalent power density below 35 kW per liter.

* * * * *

Subpart H—Averaging, Banking, and Trading for Certification

■ 189. Section 1042.701 is amended by adding paragraphs (j) and (k) to read as follows:

§ 1042.701 General provisions.

* * * * *

(j) NO_X+HC and PM credits generated under 40 CFR part 94 may be used under this part in the same manner as NO_X+HC and PM credits generated under this part.

(k) You may use either of the following approaches to retire or forego emission credits:

(1) You may retire emission credits generated from any number of your engines. This may be considered donating emission credits to the environment. Identify any such credits in the reports described in § 1042.730. Engines must comply with the applicable FELs even if you donate or sell the corresponding emission credits under this paragraph (k). Those credits may no longer be used by anyone to demonstrate compliance with any EPA emission standards.

(2) You may certify a family using an FEL below the emission standard as described in this part and choose not to generate emission credits for that family. If you do this, you do not need to calculate emission credits for those families and you do not need to submit or keep the associated records described in this subpart for that family.

■ 190. Section 1042.705 is amended by revising paragraph (c) to read as follows:

§ 1042.705 Generating and calculating emission credits.

* * * * *

(c) As described in § 1042.730, compliance with the requirements of this subpart is determined at the end of the model year based on actual U.S.-directed production volumes. Do not include any of the following engines to calculate emission credits:

(1) Engines with a permanent exemption under subpart G of this part or under 40 CFR part 1068.

(2) Exported engines.

(3) Engines not subject to the requirements of this part, such as those excluded under § 1042.5.

(4) [Reserved]

(5) Any other engines, where we indicate elsewhere in this part 1042 that they are not to be included in the calculations of this subpart.

■ 191. Section 1042.710 is amended by revising paragraph (c) to read as follows:

§ 1042.710 Averaging emission credits.

* * * * *

(c) If you certify an engine family to an FEL that exceeds the otherwise applicable emission standard, you must obtain enough emission credits to offset the engine family's deficit by the due date for the final report required in § 1042.730. The emission credits used to address the deficit may come from your other engine families that generate emission credits in the same model year, from emission credits you have banked from previous model years, or from emission credits generated in the same or previous model years that you obtained through trading.

■ 192. Section 1042.725 is amended by revising paragraph (b)(2) to read as follows:

§ 1042.725 Information required for the application for certification.

* * * * *

(b) * * *

(2) Detailed calculations of projected emission credits (positive or negative) based on projected production volumes. We may require you to include similar calculations from your other engine families to demonstrate that you will be able to avoid negative credit balances for the model year. If you project negative emission credits for a family, state the source of positive emission credits you expect to use to offset the negative emission credits.

■ 193. Section 1042.730 is amended by revising paragraphs (b) and (c)(2) to read as follows:

§ 1042.730 ABT reports.

* * * * *

(b) Your end-of-year and final reports must include the following information for each engine family participating in the ABT program:

(1) Engine-family designation and averaging set.

(2) The emission standards that would otherwise apply to the engine family.

(3) The FEL for each pollutant. If you change the FEL after the start of production, identify the date that you started using the new FEL and/or give the engine identification number for the first engine covered by the new FEL. In this case, identify each applicable FEL and calculate the positive or negative emission credits as specified in § 1042.225.

(4) The projected and actual U.S.-directed production volumes for the model year, as described in § 1042.705(c). If you changed an FEL during the model year, identify the actual U.S.-directed production volume associated with each FEL.

(5) Maximum engine power for each engine configuration, and the average engine power weighted by U.S.-directed production volumes for the engine family.

(6) Useful life.

(7) Calculated positive or negative emission credits for the whole engine family. Identify any emission credits that you traded, as described in paragraph (d)(1) of this section.

(c) * * *

(2) State whether you will retain any emission credits for banking. If you choose to retire emission credits that would otherwise be eligible for banking, identify the engine families that generated the emission credits, including the number of emission credits from each family.

* * * * *

■ 194. Section 1042.735 is amended by revising paragraphs (a) and (b) to read as follows:

§ 1042.735 Recordkeeping.

(a) You must organize and maintain your records as described in this section.

(b) Keep the records required by this section for at least eight years after the due date for the end-of-year report. You may not use emission credits for any engines if you do not keep all the records required under this section. You must therefore keep these records to continue to bank valid credits.

* * * * *

Subpart I—Special Provisions for Remanufactured Marine Engines

■ 195. Section 1042.810 is amended by revising paragraph (c) to read as follows:

§ 1042.810 Requirements for owner/operators and installers during remanufacture.

* * * * *

(c) Your engine is not subject to the standards of this subpart if we determine that no certified remanufacturing system is available for your engine as described in § 1042.815. For engines that are remanufactured during multiple events within a five-year period, you are not required to use a certified system until all of your engine's cylinders have been replaced after the system became available. For example, if you remanufacture your 16-cylinder engine by replacing four cylinders each January and a system becomes available for your engine June 1, 2010, your engine must be in a certified configuration when you replace four cylinders in January of 2014. At that point, all 16 cylinders would have been replaced after June 1, 2010.

* * * * *

■ 196. Section 1042.830 is revised to read as follows:

§ 1042.830 Labeling.

(a) The labeling requirements of this paragraph (a) apply for remanufacturing that is subject to the standards of this subpart. At the time of remanufacture, affix a permanent and legible label identifying each engine. The label must be—

(1) Attached in one piece so it is not removable without being destroyed or defaced.

(2) Secured to a part of the engine needed for normal operation and not normally requiring replacement.

(3) Durable and readable for the engine's entire useful life.

(4) Written in English.

(b) The label required under paragraph (a) of this section must—

(1) Include the heading ''EMISSION CONTROL INFORMATION''.

(2) Include your full corporate name and trademark.

(3) Include EPA's standardized designation for the engine family.

(4) State the engine's category, displacement (in liters or L/cyl), maximum engine power (in kW), and power density (in kW/L) as needed to determine the emission standards for the engine family. You may specify displacement, maximum engine power, and power density as ranges consistent with the ranges listed in § 1042.101. See § 1042.140 for descriptions of how to specify per-cylinder displacement, maximum engine power, and power density.

(5) State: ''THIS MARINE ENGINE MEETS THE STANDARDS OF 40 CFR 1042, SUBPART I, FOR [CALENDAR YEAR OF REMANUFACTURE].''

(c) For remanufactured engines that are subject to this subpart as described in § 1042.801(a), but are not subject to remanufacturing standards as allowed by § 1042.810 or § 1042.815, you may voluntarily add a label as specified in paragraphs (a) and (b) of this section, except that the label must omit the standardized designation for the engine family and include the following alternative compliance statement: ''THIS MARINE ENGINE IS NOT SUBJECT TO REMANUFACTURING STANDARDS UNDER 40 CFR 1042, SUBPART I, FOR [CALENDAR YEAR OF REMANUFACTURE].''

(d) You may add information to the emission control information label to identify other emission standards that the engine meets or does not meet (such as international standards). You may also add other information to ensure that the engine will be properly maintained and used.

(e) You may ask us to approve modified labeling requirements in this section if you show that it is necessary or appropriate. We will approve your request if your alternate label is consistent with the intent of the labeling requirements of this section.

■ 197. Section 1042.840 is amended by revising paragraphs (c) and (o) to read as follows:

§ 1042.840 Application requirements for remanufactured engines.

* * * * *

(c) Summarize the cost effectiveness analysis used to demonstrate your system will meet the availability criteria of § 1042.815. Identify the maximum allowable costs for vessel modifications to meet the criteria.

* * * * *

(o) Report all valid test results. Also indicate whether there are test results from invalid tests or from any other tests of the emission-data engine, whether or not they were conducted according to the test procedures of subpart F of this part. If you measure CO_2, report those emission levels. We may require you to report these additional test results. We may ask you to send other information to confirm that your tests were valid under the requirements of this part and 40 CFR part 1065.

* * * * *

Subpart J—Definitions and Other Reference Information

■ 198. Section 1042.901 is amended as follows:

■ a. By revising the definition of ''Designated Compliance Officer''.

■ b. By adding definitions for ''Designated Enforcement Officer'', ''Dual-fuel'', and ''Flexible-fuel''.

■ c. By revising the definition for ''Low-sulfur diesel fuel'', ''Model year'', and ''Placed into service''.

■ d. By removing the definition for ''Point of first retail sale''.

The revisions and additions read as follows:

§ 1042.901 Definitions.

* * * * *

Designated Compliance Officer means the Director, Diesel Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *complianceinfo@epa.gov*; *epa.gov/otaq/verify*.

Designated Enforcement Officer means the Director, Air Enforcement Division (2242A), U.S. Environmental Protection Agency, 1200 Pennsylvania Ave. NW.,Washington, DC 20460.

* * * * *

Dual-fuel means relating to an engine designed for operation on two different fuels but not on a continuous mixture of those fuels (see § 1042.601(j)). For purposes of this part, such an engine remains a dual-fuel engine even if it is designed for operation on three or more different fuels. Note that this definition differs from MARPOL Annex VI.

* * * * *

Flexible-fuel means relating to an engine designed for operation on any mixture of two or more different fuels (see § 1042.601(j)).

* * * * *

Low-sulfur diesel fuel means one of the following:

(1) For in-use fuels, *low-sulfur diesel fuel* means a diesel fuel marketed as low-sulfur diesel fuel having a maximum sulfur concentration of 500 parts per million.

(2) For testing, *low-sulfur diesel fuel* has the meaning given in 40 CFR part 1065.

* * * * *

Model year means any of the following:

(1) For freshly manufactured marine engines (see definition of ''new marine engine,'' paragraph (1)), model year means one of the following:

(i) Calendar year of production.

(ii) Your annual new model production period if it is different than the calendar year. This must include January 1 of the calendar year for which the model year is named. It may not begin before January 2 of the previous calendar year and it must end by December 31 of the named calendar year. For seasonal production periods not including January 1, model year means the calendar year in which the production occurs, unless you choose to certify the applicable engine family with the following model year. For example, if your production period is June 1, 2010 through November 30, 2010, your model year would be 2010 unless you choose to certify the engine family for model year 2011.

(2) For an engine that is converted to a marine engine after being certified and placed into service as a motor vehicle engine, a nonroad engine that is not a marine engine, or a stationary engine, model year means the calendar year in which the engine was originally produced. For an engine that is converted to a marine engine after being placed into service as a motor vehicle engine, a nonroad engine that is not a marine engine, or a stationary engine without having been certified, model year means the calendar year in which the engine becomes a new marine engine. (See definition of ''new marine engine,'' paragraph (2)).

(3) For an uncertified marine engine excluded under § 1042.5 that is later subject to this part 1042 as a result of being installed in a different vessel, model year means the calendar year in which the engine was installed in the non-excluded vessel. For a marine engine excluded under § 1042.5 that is later subject to this part 1042 as a result of reflagging the vessel, model year means the calendar year in which the engine was originally manufactured. For a marine engine that become new under paragraph (7) of the definition of ''new marine engine,'' model year means the calendar year in which the engine was originally manufactured. (See definition of ''new marine engine,'' paragraphs (3) and (7).)

(4) For engines that do not meet the definition of ''freshly manufactured'' but are installed in new vessels, model year means the calendar year in which the engine is installed in the new vessel (see definition of ''new marine engine,'' paragraph (4)).

(5) For remanufactured engines, model year means the calendar year in which the remanufacture takes place.

(6) For imported engines:

(i) For imported engines described in paragraph (6)(i) of the definition of ''new marine engine,'' *model year* has the meaning given in paragraphs (1) through (4) of this definition.

(ii) For imported engines described in paragraph (6)(ii) of the definition of ''new marine engine,'' *model year* means the calendar year in which the engine is remanufactured.

(iii) For imported engines described in paragraph (6)(iii) of the definition of ''new marine engine,'' *model year* means the calendar year in which the engine is first assembled in its imported configuration, unless specified otherwise in this part or in 40 CFR part 1068.

(iv) For imported engines described in paragraph (6)(iv) of the definition of ''new marine engine,'' *model year* means the calendar year in which the engine is imported.

(7) [Reserved]

(8) For freshly manufactured vessels, model year means the calendar year in which the keel is laid or the vessel is at a similar stage of construction. For vessels that become new under paragraph (2) or (3) of the definition of ''new vessel'' (as a result of modifications), model year means the calendar year in which the modifications physically begin.

* * * * *

Placed into service means put into initial use for its intended purpose. Engines and vessels do not qualify as being ''placed into service'' based on incidental use by a manufacturer or dealer.

* * * * *

■ 199. Section 1042.905 is revised to read as follows:

§ 1042.905 Symbols, acronyms, and abbreviations.

The following symbols, acronyms, and abbreviations apply to this part:

ABT	Averaging, banking, and trading.
AECD	auxiliary emission control device.
CFR	Code of Federal Regulations.
CH_4	methane.
CO	carbon monoxide.
CO_2	carbon dioxide.
cyl	cylinder.
disp.	displacement.
ECA	Emission Control Area.
EEZ	Exclusive Economic Zone.
EPA	Environmental Protection Agency.
FEL	Family Emission Limit.
g	grams.
HC	hydrocarbon.
IMO	International Maritime Organization.
hr	hours.
kPa	kilopascals.
kW	kilowatts.
L	liters.
LTR	Limited Testing Region.
N_2O	nitrous oxide.
NARA	National Archives and Records Administration.
NMHC	nonmethane hydrocarbon.
NO_X	oxides of nitrogen (NO and NO2).
NTE	not-to-exceed.
PM	particulate matter.
RPM	revolutions per minute.
SAE	Society of Automotive Engineers.
SCR	selective catalytic reduction.
THC	total hydrocarbon.
THCE	total hydrocarbon equivalent.
ULSD	ultra low-sulfur diesel fuel.
U.S.C.	United States Code.

■ 200. Section 1042.910 is revised to read as follows:

§ 1042.910 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Environmental Protection Agency must publish a notice of the change in the **Federal Register** and the material must be available to the public. All approved material is available for inspection at U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave. NW., Room B102, EPA West Building, Washington, DC 20460, (202) 202–1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

(b) The International Maritime Organization, 4 Albert Embankment, London SE1 7SR, United Kingdom, or *www.imo.org*, or 44–(0)20–7735–7611.

(1) MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships, Third Edition, 2013, and NO_x Technical Code 2008.

(i) Revised MARPOL Annex VI, Regulations for the Prevention of Pollution from Ships, Third Edition, 2013 (''2008 Annex VI''); IBR approved for § 1042.901.

(ii) NO_x Technical Code 2008, Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines, 2013 Edition, (''NO_x Technical Code''); IBR approved for §§ 1042.104(g), 1042.230(d), 1042.302(c) and (e), 1042.501(g), and 1042.901.

(iii) Annex 12, Resolution MEPC.251(66) from the Report of the Marine Environment Protection Committee on its Sixty-Sixth Session, April 25, 2014. This document describes new and revised provisions that are considered to be part of Annex VI and NO_x Technical Code 2008 as referenced in paragraphs (a)(1)(i) and (ii) of this section. IBR approved for §§ 1042.104(g), 1042.230(d), 1042.302(c) and (e), 1042.501(g), and 1042.901.

(2) [Reserved]

■ 201. Section 1042.915 is revised to read as follows:

§ 1042.915 Confidential information.

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

■ 202. Section 1042.925 is revised to read as follows:

§ 1042.925 Reporting and recordkeeping requirements.

(a) This part includes various requirements to submit and record data or other information. Unless we specify otherwise, store required records in any format and on any media and keep them readily available for eight years after you send an associated application for certification, or eight years after you generate the data if they do not support an application for certification. You are expected to keep your own copy of required records rather than relying on someone else to keep records on your behalf. We may review these records at any time. You must promptly send us organized, written records in English if we ask for them. We may require you to submit written records in an electronic format.

(b) The regulations in § 1042.255, 40 CFR 1068.25, and 40 CFR 1068.101 describe your obligation to report truthful and complete information. This includes information not related to certification. Failing to properly report information and keep the records we specify violates 40 CFR 1068.101(a)(2), which may involve civil or criminal penalties.

(c) Send all reports and requests for approval to the Designated Compliance Officer (see § 1042.801).

(d) Any written information we require you to send to or receive from another company is deemed to be a required record under this section. Such records are also deemed to be submissions to EPA. We may require you to send us these records whether or not you are a certificate holder.

(e) Under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*), the Office of Management and Budget approves the reporting and recordkeeping specified in the applicable regulations. The following items illustrate the kind of reporting and recordkeeping we require for engines and vessels regulated under this part:

(1) We specify the following requirements related to engine certification in this part 1042:

(i) In § 1042.135 we require engine manufacturers to keep certain records related to duplicate labels sent to vessel manufacturers.

(ii) In § 1042.145 we state the requirements for interim provisions.

(iii) In subpart C of this part we identify a wide range of information required to certify engines.

(iv) In §§ 1042.345 and 1042.350 we specify certain records related to production-line testing.

(v) In subpart G of this part we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various special compliance provisions.

(vi) In §§ 1042.725, 1042.730, and 1042.735 we specify certain records related to averaging, banking, and trading.

(vii) In subpart I of this part we specify certain records related to meeting requirements for remanufactured engines.

(2) We specify the following requirements related to testing in 40 CFR part 1065:

(i) In 40 CFR 1065.2 we give an overview of principles for reporting information.

(ii) In 40 CFR 1065.10 and 1065.12 we specify information needs for establishing various changes to published test procedures.

(iii) In 40 CFR 1065.25 we establish basic guidelines for storing test information.

(iv) In 40 CFR 1065.695 we identify the specific information and data items to record when measuring emissions.

(3) We specify the following requirements related to the general

compliance provisions in 40 CFR part 1068:

(i) In 40 CFR 1068.5 we establish a process for evaluating good engineering judgment related to testing and certification.

(ii) In 40 CFR 1068.25 we describe general provisions related to sending and keeping information.

(iii) In 40 CFR 1068.27 we require manufacturers to make engines available for our testing or inspection if we make such a request.

(iv) In 40 CFR 1068.105 we require vessel manufacturers to keep certain records related to duplicate labels from engine manufacturers.

(v) In 40 CFR 1068.120 we specify recordkeeping related to rebuilding engines.

(vi) In 40 CFR part 1068, subpart C, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various exemptions.

(vii) In 40 CFR part 1068, subpart D, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to importing engines.

(viii) In 40 CFR 1068.450 and 1068.455 we specify certain records related to testing production-line engines in a selective enforcement audit.

(ix) In 40 CFR 1068.501 we specify certain records related to investigating and reporting emission-related defects.

(x) In 40 CFR 1068.525 and 1068.530 we specify certain records related to recalling nonconforming engines.

■ 203. Appendix II is revised to read as follows:

Appendix II to Part 1042—Steady-State Duty Cycles

(a) The following duty cycles apply as specified in § 1042.505(b)(1):

(1) The following duty cycle applies for discrete-mode testing:

E3 mode No.	Engine speed[1]	Percent of maximum test power	Weighting factors
1	Maximum test speed	100	0.2
2	91%	75	0.5
3	80%	50	0.15
4	63%	25	0.15

[1] Maximum test speed is defined in 40 CFR part 1065. Percent speed values are relative to maximum test speed.

(2) The following duty cycle applies for ramped-modal testing:

RMC mode	Time in mode (seconds)	Engine speed[1 3]	Power (percent)[2 3]
1a Steady-state	229	Maximum test speed	100%.
1b Transition	20	Linear transition	Linear transition in torque.
2a Steady-state	166	63%	25%.
2b Transition	20	Linear transition	Linear transition in torque.
3a Steady-state	570	91%	75%.
3b Transition	20	Linear transition	Linear transition in torque.
4a Steady-state	175	80%	50%.

[1] Maximum test speed is defined in 40 CFR part 1065. Percent speed is relative to maximum test speed.
[2] The percent power is relative to the maximum test power.
[3] Advance from one mode to the next within a 20-second transition phase. During the transition phase, command a linear progression from the torque setting of the current mode to the torque setting of the next mode, and simultaneously command a similar linear progression for engine speed if there is a change in speed setting.

(b) The following duty cycles apply as specified in § 1042.505(b)(2):

(1) The following duty cycle applies for discrete-mode testing:

E5 mode No.	Engine speed[1]	Percent of maximum test power	Weighting factors
1	Maximum test speed	100	0.08
2	91%	75	0.13
3	80%	50	0.17
4	63%	25	0.32
5	Warm idle	0	0.3

[1] Maximum test speed is defined in 40 CFR part 1065. Percent speed values are relative to maximum test speed.

(2) The following duty cycle applies for ramped-modal testing:

RMC mode	Time in mode (seconds)	Engine speed [1 3]	Power (percent) [2 3]
1a Steady-state	167	Warm idle	0%.
1b Transition	20	Linear transition	Linear transition in torque.
2a Steady-state	85	Maximum test speed	100%.
2b Transition	20	Linear transition	Linear transition in torque.
3a Steady-state	354	63%	25%.
3b Transition	20	Linear transition	Linear transition in torque.
4a Steady-state	141	91%	75%.
4b Transition	20	Linear transition	Linear transition in torque.
5a Steady-state	182	80%	50%.
5b Transition	20	Linear transition	Linear transition in torque.
6 Steady-state	171	Warm idle	0%.

[1] Maximum test speed is defined in 40 CFR part 1065. Percent speed is relative to maximum test speed.
[2] The percent power is relative to the maximum test power.
[3] Advance from one mode to the next within a 20-second transition phase. During the transition phase, command a linear progression from the torque setting of the current mode to the torque setting of the next mode, and simultaneously command a similar linear progression for engine speed if there is a change in speed setting.

(c) The following duty cycles apply as specified in § 1042.505(b)(3):

(1) The following duty cycle applies for discrete-mode testing:

E2 mode No.	Engine speed [1]	Torque (percent) [2]	Weighting factors
1	Engine Governed	100	0.2
2	Engine Governed	75	0.5
3	Engine Governed	50	0.15
4	Engine Governed	25	0.15

[1] Speed terms are defined in 40 CFR part 1065.
[2] The percent torque is relative to the maximum test torque as defined in 40 CFR part 1065.

(2) The following duty cycle applies for ramped-modal testing:

RMC mode	Time in mode (seconds)	Engine speed	Torque (percent) [1 2]
1a Steady-state	229	Engine Governed	100%.
1b Transition	20	Engine Governed	Linear transition.
2a Steady-state	166	Engine Governed	25%.
2b Transition	20	Engine Governed	Linear transition.
3a Steady-state	570	Engine Governed	75%.
3b Transition	20	Engine Governed	Linear transition.
4a Steady-state	175	Engine Governed	50%.

[1] The percent torque is relative to the maximum test torque as defined in 40 CFR part 1065.
[2] Advance from one mode to the next within a 20-second transition phase. During the transition phase, command a linear progression from the torque setting of the current mode to the torque setting of the next mode.

■ 204. Appendix III is revised to read as follows:

Appendix III to Part 1042—Not-To-Exceed Zones

(a) The following definitions apply for this Appendix III:

(1) *Percent power* means the percentage of the maximum power achieved at Maximum Test Speed (or at Maximum Test Torque for constant-speed engines).

(2) *Percent speed* means the percentage of Maximum Test Speed.

(b) Figure 1 of this Appendix illustrates the default NTE zone for marine engines certified using the duty cycle specified in § 1042.505(b)(1), except for variable-speed propulsion marine engines used with controllable-pitch propellers or with electrically coupled propellers, as follows:

(1) Subzone 1 is defined by the following boundaries:

(i) Percent power ÷ 100 ≥ 0.7 · (percent speed ÷ 100)$^{2.5}$.

(ii) Percent power ÷ 100 ≤ (percent speed ÷ 90)$^{3.5}$.

(iii) Percent power ÷ 100 ≥ 3.0 · (1 − percent speed ÷ 100).

(2) Subzone 2 is defined by the following boundaries:

(i) Percent power ÷ 100 ≥ 0.7 · (percent speed ÷ 100)$^{2.5}$.

(ii) Percent power ÷ 100 ≤ (percent speed ÷ 90)$^{3.5}$.

(iii) Percent power ÷ 100 < 3.0 · (1 − percent speed ÷ 100).

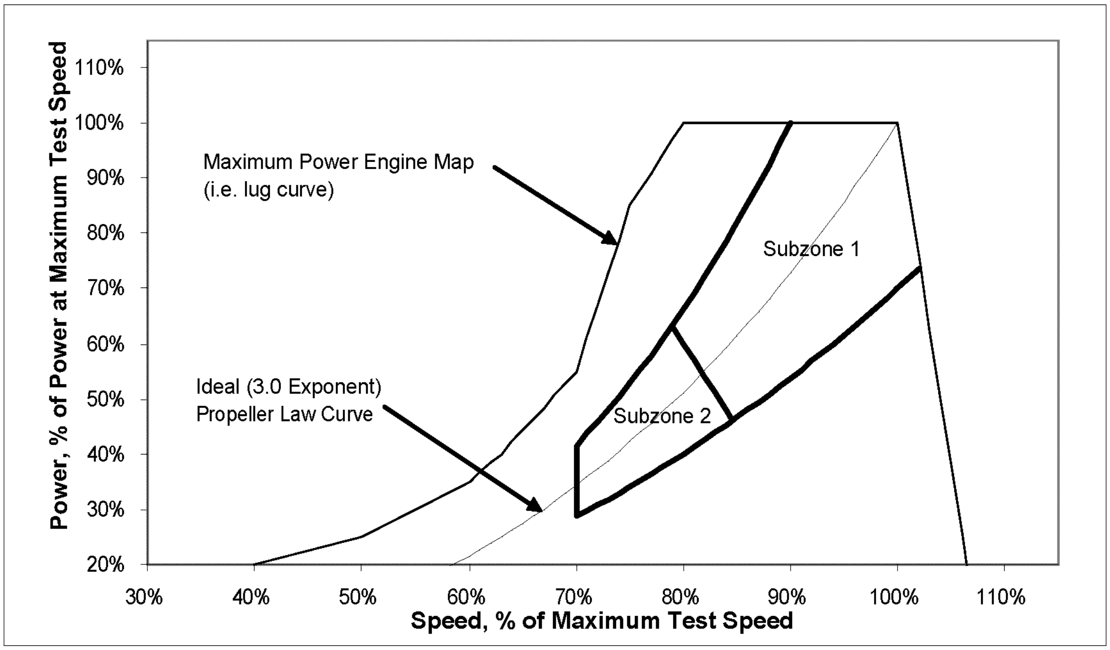
(iv) Percent speed ÷ 100 ≥ 0.7.

(3) Note that the line separating Subzone 1 and Subzone 2 includes the following endpoints:

(i) Percent speed = 78.9 percent; Percent power = 63.2 percent.

(ii) Percent speed = 84.6 percent; Percent power = 46.1 percent.

Figure 1 of Appendix III — NTE Zone and Subzones for Propeller-Law Marine Engines



(c) Figure 2 of this Appendix illustrates the default NTE zone for recreational marine engines certified using the duty cycle specified in § 1042.505(b)(2), except for variable-speed marine engines used with controllable-pitch propellers or with electrically coupled propellers, as follows:

(1) Subzone 1 is defined by the following boundaries:

(i) Percent power ÷ 100 ≥ 0.7 · (percent speed ÷ 100)$^{2.5}$.

(ii) Percent power ÷ 100 ≤ (percent speed ÷ 90)$^{3.5}$.

(iii) Percent power ÷ 100 ≥ 3.0 · (1 − percent speed ÷ 100).

(iv) Percent power ≤ 95 percent.

(2) Subzone 2 is defined by the following boundaries:

(i) Percent power ÷ 100 ≥ 0.7 · (percent speed ÷ 100)$^{2.5}$.

(ii) Percent power ÷ 100 ≤ (percent speed ÷ 90)$^{3.5}$.

(iii) Percent power ÷ 100 < 3.0 · (1 − percent speed ÷ 100).

(iv) Percent speed ≥ 70 percent.

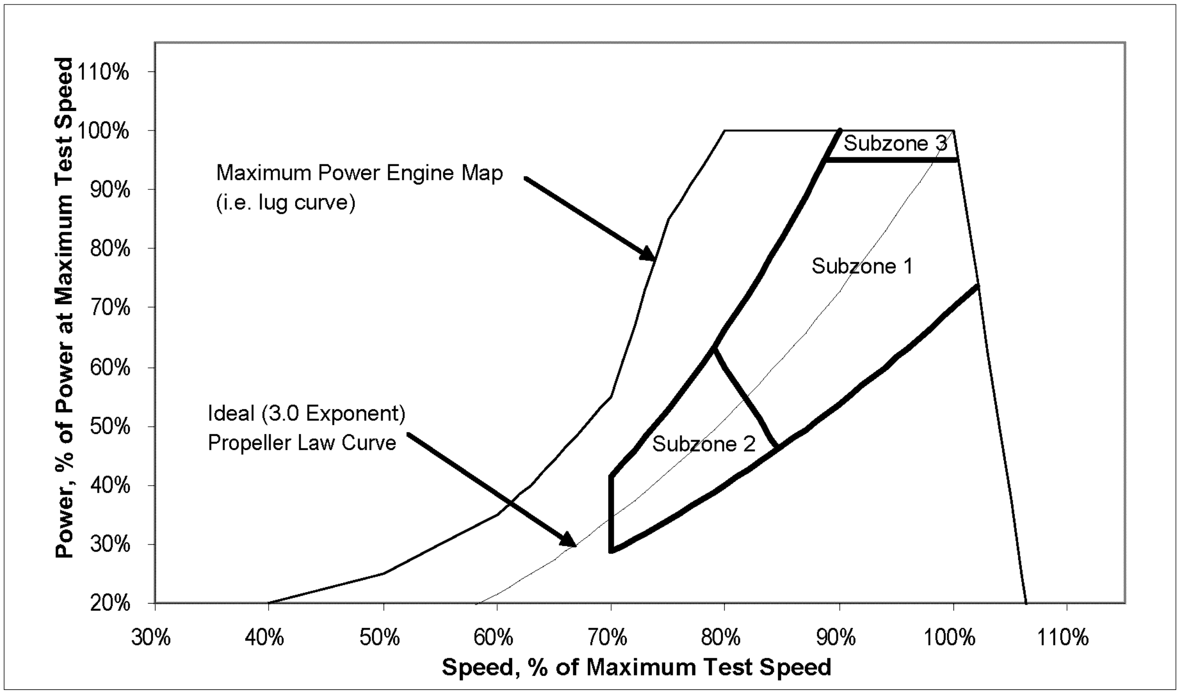
(3) Subzone 3 is defined by the following boundaries:

(i) Percent power ÷ 100 ≤ (percent speed ÷ 90)$^{3.5}$.

(ii) Percent power > 95 percent.

(4) Note that the line separating Subzone 1 and Subzone 3 includes a point at Percent speed = 88.7 percent and Percent power = 95.0 percent. See paragraph (b)(3) of this appendix regarding the line separating Subzone 1 and Subzone 2.

Figure 2 of Appendix III — NTE Zone and Subzones for Propeller-Law Recreational Marine Engines



(d) Figure 3 of this Appendix illustrates the default NTE zone for variable-speed marine engines used with controllable-pitch propellers or with electrically coupled propellers that are certified using the duty cycle specified in § 1042.505(b)(1), (2), or (3), as follows:

(1) Subzone 1 is defined by the following boundaries:

(i) Percent power ÷ 100 ≥ 0.7 · (percent speed ÷ 100)$^{2.5}$.

(ii) Percent power ÷ 100 ≥ 3.0 · (1 − percent speed ÷ 100).

(iii) Percent speed ≥ 78.9 percent.

(2) Subzone 2a is defined by the following boundaries:

(i) Percent power ÷ 100 ≥ 0.7 • (percent speed ÷ 100)$^{2.5}$.

(ii) Percent speed ≥ 70 percent.

(iii) Percent speed < 78.9 percent, for Percent power > 63.3 percent.

(iv) Percent power ÷ 100 < 3.0 · (1 − percent speed ÷ 100), for Percent speed ≥ 78.9 percent.

(3) Subzone 2b is defined by the following boundaries:

(i) The line formed by connecting the following two points on a plot of speed-vs.-power:

(A) Percent speed = 70 percent; Percent power = 28.7 percent.

(B) Percent power = 40 percent; Speed = governed speed.

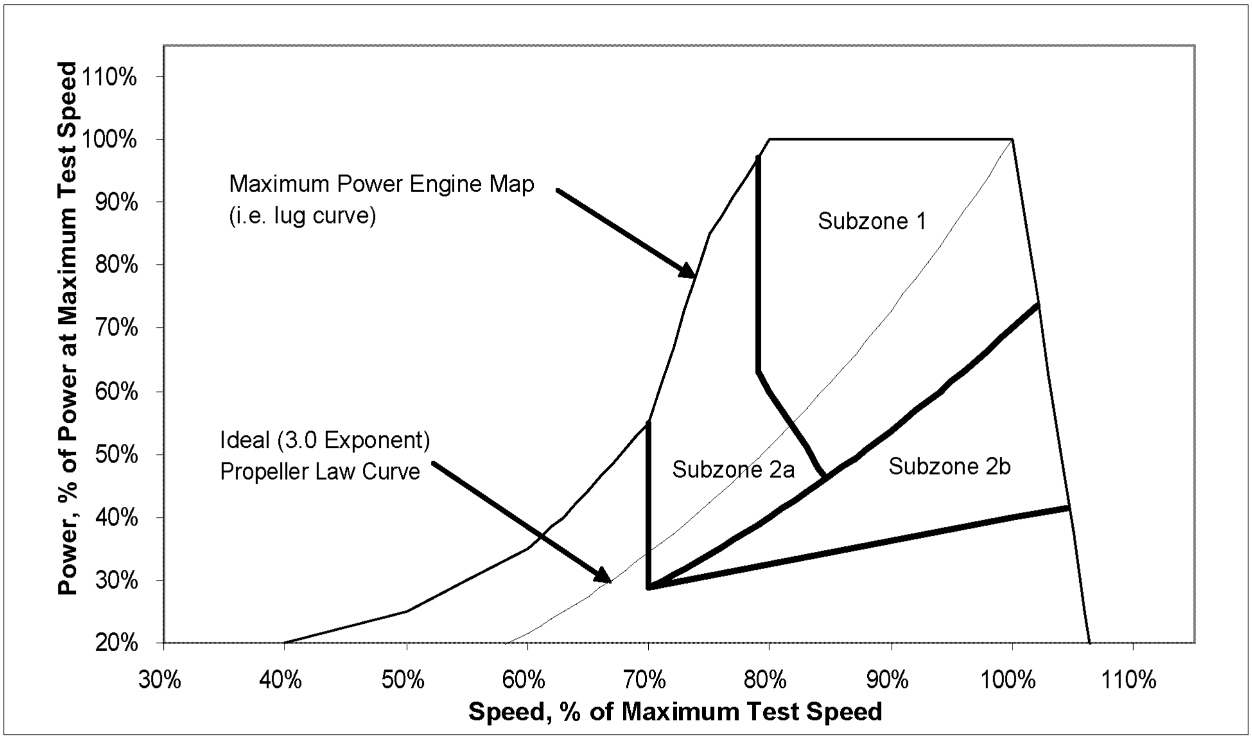
(ii) Percent power ÷ 100 < 0.7 · (percent speed ÷ 100)$^{2.5}$.

(4) Note that the line separating Subzone 1 and Subzone 2a includes the following endpoints:

(i) Percent speed = 78.9 percent; Percent power = 63.3 percent.

(ii) Percent speed = 84.6 percent; Percent power = 46.1 percent.

Figure 3 of Appendix III — NTE Zone and Subzones for Variable-Pitch or Electronically Coupled Engines*



*Shown for engines capable of operating on the E3 Duty Cycle.

(e) Figure 4 of this Appendix illustrates the default NTE zone for constant-speed engines certified using a duty cycle specified in § 1042.505(b)(3) or (b)(4), as follows:

(1) Subzone 1 is defined by the following boundaries:

(i) Percent power ≥ 70 percent.

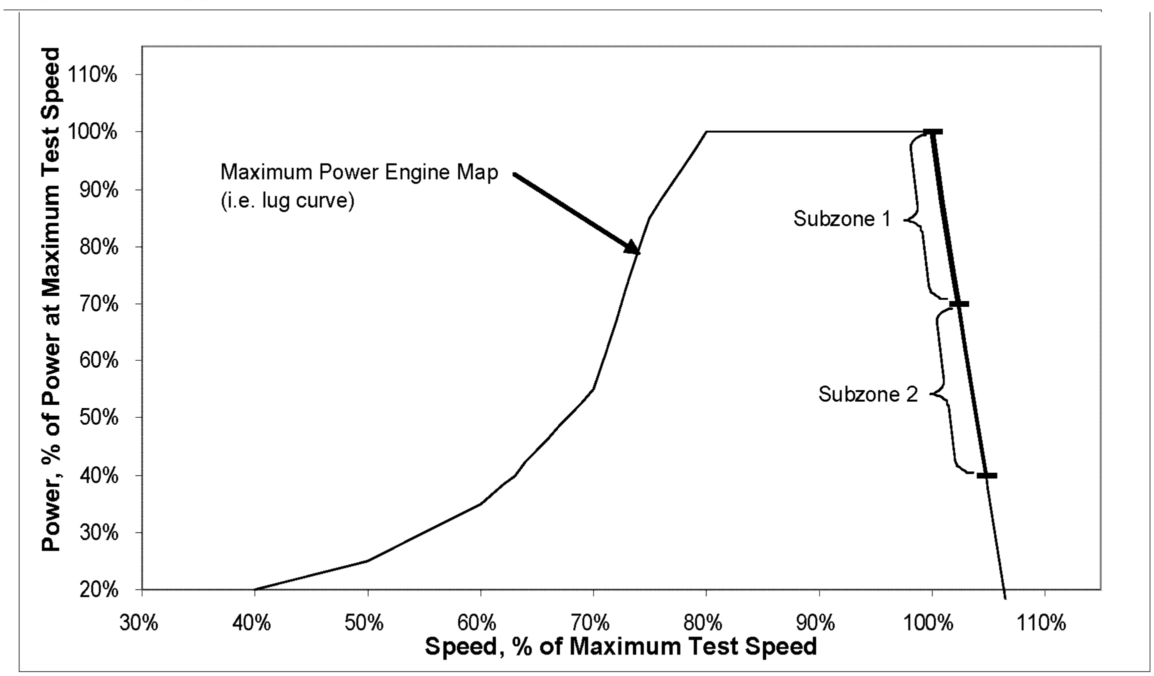
(ii) [Reserved]

(2) Subzone 2 is defined by the following boundaries:

(i) Percent power < 70 percent.

(ii) Percent power ≥ 40 percent.

Figure 4 of Appendix III — NTE Zone and Subzones for Constant-Speed Marine Engines

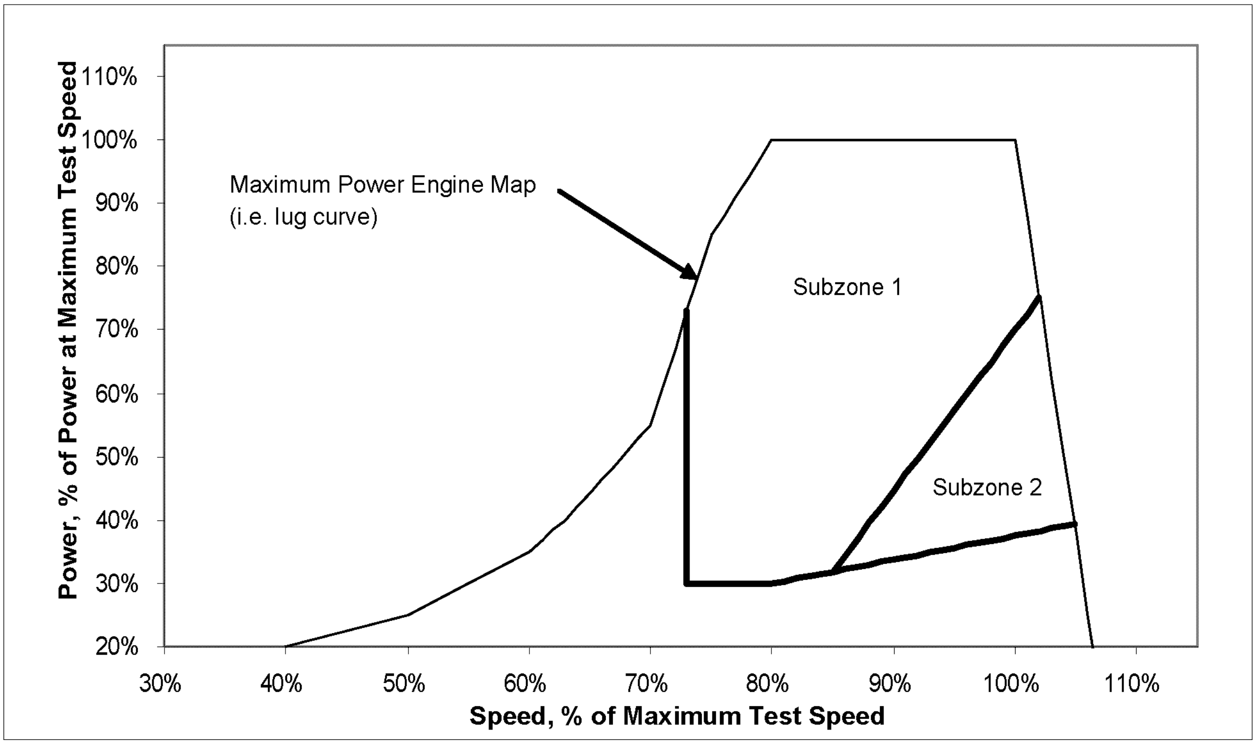


(f) Figure 5 of this Appendix illustrates the default NTE zone for variable-speed auxiliary marine engines certified using the duty cycle specified in § 1042.505(b)(5)(ii) or (iii), as follows:

(1) The default NTE zone is defined by the boundaries specified in 40 CFR 86.1370(b)(1), (2), and (4).

(2) A special PM subzone is defined in 40 CFR 1039.515(b).

Figure 5 of Appendix III — NTE Zone and Subzones for Variable-Speed Auxiliary Marine Engines (nonpropeller-law)



PART 1043—CONTROL OF NO_X, SO_X, AND PM EMISSIONS FROM MARINE ENGINES AND VESSELS SUBJECT TO THE MARPOL PROTOCOL

■ 205. The authority citation for part 1043 continues to read as follows:

Authority: 33 U.S.C. 1901–1912.

■ 206. Section 1043.60 is amended by revising paragraph (a) introductory text to read as follows:

§ 1043.60 Operating requirements for engines and vessels subject to this part.

* * * * *

(a) Except as specified otherwise in this part, NO_X emission limits apply to all engines with power output of more than 130 kW that will be installed on vessels subject to this part as specified in the following table:

* * * * *

■ 207. Section 1043.100 is revised to read as follows:

§ 1043.100 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Environmental Protection Agency must publish a notice of the change in the **Federal Register** and the material must be available to the public. All approved material is available for inspection at U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave. NW., Room B102, EPA West Building, Washington, DC 20460, (202) 202–1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.*

(b) The International Maritime Organization, 4 Albert Embankment, London SE1 7SR, United Kingdom, or *www.imo.org, or 44–(0)20–7735–7611.*

(1) MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships, Third Edition, 2013, and NO_X Technical Code 2008.

(i) Revised MARPOL Annex VI, Regulations for the Prevention of Pollution from Ships, Third Edition, 2013 (''2008 Annex VI''); IBR approved for §§ 1043.1 introductory text, 1043.20, 1043.30(f), 1043.60(c), and 1043.70(a).

(ii) NO_X Technical Code 2008, Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines, 2013 Edition, (''NO_X Technical Code''); IBR approved for §§ 1043.20, 1043.41(b) and (h), and 1043.70(a).

(iii) Annex 12, Resolution MEPC.251(66) from the Report of the Marine Environment Protection Committee on its Sixty-Sixth Sesson, April 25, 2014. This document describes new and revised provisions that are considered to be part of Annex VI and NO_X Technical Code 2008 as referenced in paragraphs (a)(1)(i) and (ii) of this section. IBR approved for §§ 1043.1 introductory text, 1043.20, 1043.30(f), 1043.41(b) and (h), 1043.60(c), and 1043.70(a).

(2) [Reserved]

PART 1065—ENGINE-TESTING PROCEDURES

■ 208. The authority citation for part 1065 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart A—Applicability and General Provisions

■ 209. Section 1065.15 is amended by revising paragraphs (a)(2)(ii) and (iv) to read as follows:

§ 1065.15 Overview of procedures for laboratory and field testing.

* * * * *

(a) * * *

(2) * * *

(ii) Nonmethane hydrocarbon, NMHC, which results from subtracting methane, CH_4, from THC. You may choose to measure NMOG emissions to demonstrate compliance with NMHC standards.

* * * * *

(iv) Nonmethane hydrocarbon-equivalent, NMHCE, which results from adjusting NMHC mathematically to be equivalent on a carbon-mass basis. You may choose to measure NMOG emissions to demonstrate compliance with NMHCE standards.

* * * * *

Subpart F—Performing an Emission Test in the Laboratory

■ 210. Section 1065.510 is amended by revising paragraphs (c) introductory text and (d)(5)(iii) to read as follows:

§ 1065.510 Engine mapping.

* * * * *

(c) *Negative torque mapping.* If your engine is subject to a reference duty cycle that specifies negative torque values (*i.e.,* engine motoring), generate a motoring torque curve by any of the following procedures:

* * * * *

(d) * * *

(5) * * *

(iii) For any isochronous governed (0% speed droop) constant-speed engine, you may map the engine with two points as described in this paragraph (d)(5)(iii). After stabilizing at the no-load governed speed in paragraph (d)(4) of this section, record the mean feedback speed and torque. Continue to operate the engine with the governor or simulated governor controlling engine speed using operator demand, and control the dynamometer to target a speed of 99.5% of the recorded mean no-load governed speed. Allow speed and torque to stabilize. Record the mean feedback speed and torque. Record the target speed. The absolute value of the speed error (the mean feedback speed minus the target speed) must be no greater than 0.1% of the recorded mean no-load governed speed. From this series of two mean feedback speed and torque values, use linear interpolation to determine intermediate values. Use this series of two mean feedback speeds and torques to generate a power map as described in paragraph (e) of this section. Note that the measured maximum test torque as determined in § 1065.610 (b)(1) will be the mean feedback torque recorded on the second point.

* * * * *

Subpart G—Calculations and Data Requirements

■ 211. Section 1065.610 is amended by revising paragraphs (a)(1)(ii), (a)(1)(iii), (a)(1)(vi), (b), and (c)(1) and (2) to read as follows:

§ 1065.610 Duty cycle generation.

* * * * *

(a) * * *

(1) * * *

(ii) Determine the lowest and highest engine speeds corresponding to 98% of P_{max}, using linear interpolation, and no extrapolation, as appropriate.

(iii) Determine the engine speed corresponding to maximum power, f_{nPmax}, by calculating the average of the two speed values from paragraph (a)(1)(ii) of this section. If there is only one speed where power is equal to 98% of P_{max}, take f_{nPmax} as the speed at which P_{max} occurs.

* * * * *

(vi) Determine the lowest and highest engine speeds corresponding to the value calculated in paragraph (a)(1)(v) of this section, using linear interpolation as appropriate. Calculate f_{ntest} as the average of these two speed values. If there is only one speed corresponding to the value calculated in paragraph (a)(1)(v) of this section, take f_{ntest} as the speed where the maximum of the sum of the squares occurs.

* * * * *

(b) *Maximum test torque, T_{test}.* For constant-speed engines, determine the measured T_{test} from the torque and power-versus-speed maps, generated according to § 1065.510, as follows:

(1) For constant speed engines mapped using the methods in § 1065.510(d)(5)(i) or (ii), determine T_{test} as follows:

(i) Determine maximum power, P_{max}, from the engine map generated according to § 1065.510 and calculate the value for power equal to 98% of P_{max}.

(ii) Determine the lowest and highest engine speeds corresponding to 98% of P_{max}, using linear interpolation, and no extrapolation, as appropriate.

(iii) Determine the engine speed corresponding to maximum power, f_{nPmax}, by calculating the average of the two speed values from paragraph (a)(1)(ii) of this section. If there is only one speed where power is equal to 98% of P_{max}, take f_{nPmax} as the speed at which P_{max} occurs.

(iv) Transform the map into a normalized power-versus-speed map by dividing power terms by P_{max} and dividing speed terms by f_{nPmax}. Use the Equation 1065.610–1 to calculate a quantity representing the sum of squares from the normalized map.

(v) Determine the maximum value for the sum of the squares from the map and multiply that value by 0.98.

(vi) Determine the lowest and highest engine speeds corresponding to the value calculated in paragraph (a)(1)(v) of this section, using linear interpolation as appropriate. Calculate f_{ntest} as the average of these two speed values. If there is only one speed corresponding to the value calculated in paragraph (a)(1)(v) of this section, take f_{ntest} as the speed where the maximum of the sum of the squares occurs.

(vii) The measured T_{test} is the mapped torque at f_{ntest}.

(2) For constant-speed engines using the two-point mapping method in § 1065.510(d)(5)(iii), you may follow paragraph (a)(1) of this section to determine the measured $T_{test,}$ or you may use the measured torque of the second point as the measured T_{test} directly.

(3) Transform normalized torques to reference torques according to paragraph (d) of this section by using the measured maximum test torque determined according to paragraph (b)(1) of this section—or use your declared maximum test torque, as allowed in § 1065.510.

(c) * * *

(1) *% speed.* If your normalized duty cycle specifies % speed values, use your warm idle speed and your maximum test speed to transform the duty cycle, as follows:

$$f_{nref} = \%\,speed \cdot (f_{ntest} - f_{nidle}) + f_{nidle} \qquad \text{Eq. 1065.610-3}$$

Example:

% speed = 85%
f_{ntest} = 2364 r/min
f_{nidle} = 650 r/min
f_{nref} = 85% · (2364 − 650) + 650
f_{nref} = 2107 r/min

(2) *A, B, and C speeds.* If your normalized duty cycle specifies speeds as A, B, or C values, use your power-versus-speed curve to determine the lowest speed below maximum power at which 50% of maximum power occurs. Denote this value as n_{lo}. Take n_{lo} to be warm idle speed if all power points at speeds below the maximum power speed are higher than 50% of maximum power. Also determine the highest speed above maximum power at which 70% of maximum power occurs. Denote this value as n_{hi}. If all power points at speeds above the maximum power speed are higher than 70% of maximum power, take n_{hi} to be the declared maximum safe engine speed or the declared maximum representative engine speed, whichever is lower. Use n_{hi} and n_{lo} to calculate reference values for A, B, or C speeds as follows:

$$f_{nrefA} = 0.25 \cdot (n_{hi} - n_{lo}) + n_{lo} \qquad \text{Eq. 1065.610-4}$$

$$f_{nrefB} = 0.50 \cdot (n_{hi} - n_{lo}) + n_{lo} \qquad \text{Eq. 1065.610-5}$$

$$f_{nrefC} = 0.75 \cdot (n_{hi} - n_{lo}) + n_{lo} \qquad \text{Eq. 1065.610-6}$$

Example:

n_{lo} = 1005 r/min
n_{hi} = 2385 r/min
f_{nrefA} = 0.25 · (2385 − 1005) + 1005
f_{nrefB} = 0.50 · (2385 − 1005) + 1005
f_{nrefC} = 0.75 · (2385 − 1005) + 1005
f_{nrefA} = 1350 r/min
f_{nrefB} = 1695 r/min
f_{nrefC} = 2040 r/min

* * * * *

■ 212. Section 1065.655 is amended by revising paragraph (d)(1) to read as follows:

§ 1065.655 Chemical balances of fuel, intake air, and exhaust.

* * * * *

(d) * * *

(1) You may calculate w_C as described in this paragraph (d)(1) based on measured fuel properties. To do so, you must determine values for α and β in all cases, but you may set γ and δ to zero if the default value listed in Table 1 of this section is zero. Calculate w_C using the following equation:

$$w_C = \frac{1 \cdot M_C}{1 \cdot M_C + \alpha \cdot M_H + \beta \cdot M_O + \gamma \cdot M_S + \delta \cdot M_N} \qquad \text{Eq. 1065.655-19}$$

Where:

w_C = carbon mass fraction of fuel.
M_C = molar mass of carbon.
α = atomic hydrogen-to-carbon ratio of the mixture of fuel(s) being combusted.
M_H = molar mass of hydrogen.
β = atomic oxygen-to-carbon ratio of the mixture of fuel(s) being combusted.
M_O = molar mass of oxygen.
γ = atomic sulfur-to-carbon ratio of the mixture of fuel(s) being combusted.
M_S = molar mass of sulfur.
δ = atomic nitrogen-to-carbon ratio of the mixture of fuel(s) being combusted.
M_N = molar mass of nitrogen.

Example:

α = 1.8
β = 0.05
γ = 0.0003
δ = 0.0001
M_C = 12.0107
M_H = 1.00794
M_O = 15.9994
M_S = 32.065
M_N = 14.0067

$\alpha = 1.8$

$\beta = 0.05$

$\gamma = 0.0003$

$\delta = 0.0001$

$M_C = 12.0107$

$M_H = 1.00794$

$M_O = 15.9994$

$M_S = 32.065$

$M_N = 14.0067$

$$w_C = \frac{1 \cdot 12.0107}{1 \cdot 12.0107 + 1.8 \cdot 1.00794 + 0.05 \cdot 15.9994 + 0.0003 \cdot 32.065 + 0.0001 \cdot 14.0067}$$

$w_C = 0.8206$

$w_C = 0.8206$

* * * * *

■ 213. Section 1065.680 is added to read as follows:

§ 1065.680 Adjusting emission levels to account for infrequently regenerating aftertreatment devices.

This section describes how to calculate and apply emission adjustment factors for engines using aftertreatment technology with infrequent regeneration events that may occur during testing. These adjustment factors are typically calculated based on measurements conducted for the purposes of engine certification, and then used to adjust the results of testing related to demonstrating compliance with emission standards. For this section, ''regeneration'' means an intended event during which emission levels change while the system restores aftertreatment performance. For example, exhaust gas temperatures may increase temporarily to remove sulfur from adsorbers or to oxidize accumulated particulate matter in a trap. Also, ''infrequent'' refers to regeneration events that are expected to occur on average less than once over a transient or ramped-modal duty cycle, or on average less than once per mode in a discrete-mode test.

(a) *Adjustment factors.* Apply adjustment factors based on whether there is active regeneration during a test segment. The test segment may be a test interval or a full duty cycle, as described in paragraph (b) of this section. For engines subject to standards over more than one duty cycle, you must develop adjustment factors under this section for each separate duty cycle. You must be able to identify active regeneration in a way that is readily apparent during all testing. All adjustment factors for regeneration are additive.

(1) If active regeneration does not occur during a test segment, apply an upward adjustment factor, *UAF,* that will be added to the measured emission rate for that test segment. Use the following equation to calculate *UAF:*

$$UAF_{[cycle]} = EF_{A[cycle]} - EF_{L[cycle]} \quad \text{Eq. 1065.680-1}$$

Where:

$EF_{A[cycle]}$ = the average emission factor over the test segment as determined in paragraph (a)(4) of this section.

$EF_{L[cycle]}$ = measured emissions over a complete test segment in which active regeneration does not occur.

Example:

EF_{ARMC} = 0.15 g/kW·hr

EF_{LRMC} = 0.11 g/kW·hr

UAF_{RMC} = 0.15 − 0.11 = 0.04 g/kW·hr

(2) If active regeneration occurs or starts to occur during a test segment, apply a downward adjustment factor, *DAF,* that will be subtracted from the measured emission rate for that test segment. Use the following equation to calculate *DAF:*

$$DAF_{[cycle]} = EF_{H[cycle]} - EF_{A[cycle]} \quad \text{Eq. 1065.680-2}$$

Where:

$EF_{H[cycle]}$ = measured emissions over the test segment from a complete regeneration event, or the average emission rate over multiple complete test segments with regeneration if the complete regeneration event lasts longer than one test segment.

Example:

EF_{ARMC} = 0.15 g/kW·hr

EF_{HRMC} = 0.50 g/kW·hr

DAF_{RMC} = 0.50 − 0.15 = 0.35 g/kW·hr

(3) Note that emissions for a given pollutant may be lower during regeneration, in which case EF_L would be greater than EF_H, and both *UAF* and *DAF* would be negative.

(4) Calculate the average emission factor, EF_A, as follows:

$$EF_{A[cycle]} = F_{[cycle]} \cdot EF_{H[cycle]} + (1.00 - F_{[cycle]}) \cdot EF_{L[cycle]} \quad \text{Eq. 1065.680-3}$$

Where:

$F_{[cycle]}$ = the frequency of the regeneration event during the test segment, expressed in terms of the fraction of equivalent test segments during which active regeneration occurs, as described in paragraph (a)(5) of this section.

Example:

F_{RMC} = 0.10

EF_{ARMC} = 0.10 · 0.50 + (1.00 − 0.10) · 0.11 = 0.15 g/kW·hr

(5) The frequency of regeneration, *F*, generally characterizes how often a regeneration event occurs within a series of test segments. Determine *F* using the following equation, subject to the provisions of paragraph (a)(6) of this section:

$$F_{[cycle]} = \frac{i_{r[cycle]}}{i_{f[cycle]} + i_{r[cycle]}} \quad \text{Eq. 1065.680-4}$$

Where:

$i_{r[cycle]}$ = the number of successive test segments required to complete an active regeneration, rounded up to the next whole number.

$i_{f[cycle]}$ = the number of test segments from the end of one complete regeneration event to the start of the next active regeneration, without rounding.

Example:

$$i_{rRMC} = 2$$

$$i_{fRMC} = 17.86$$

$$F_{RMC} = \frac{2}{17.86 + 2} = 0.10$$

(6) Use good engineering judgment to determine i_r and i_f, as follows:

(i) For engines that are programmed to regenerate after a specific time interval, you may determine the duration of a regeneration event and the time between regeneration events based on the engine's design parameters. For other engines, determine these values based on measurements from in-use operation or from running repetitive duty cycles in a laboratory.

(ii) For engines subject to standards over multiple duty cycles, such as for transient and steady-state testing, apply this same calculation to determine a value of *F* for each duty cycle.

(iii) Consider an example for an engine that is designed to regenerate its PM filter 500 minutes after the end of the last regeneration event, with the regeneration event lasting 30 minutes. If the RMC takes 28 minutes, i_{rRMC} = 2 (30 ÷ 28 = 1.07, which rounds up to 2), and i_{fRMC} = 500 ÷ 28 = 17.86.

(b) Develop adjustment factors for different types of testing as follows:

(1) *Discrete-mode testing.* Develop separate adjustment factors for each test mode (test interval) of a discrete-mode test. When measuring EF_H, if a regeneration event has started but is not complete when you reach the end of the sampling time for a test interval, extend the sampling period for that test interval until the regeneration event is complete.

(2) *Ramped-modal and transient testing.* Develop a separate set of adjustment factors for an entire ramped-modal cycle or transient duty cycle. When measuring EF_H, if a regeneration event has started but is not complete when you reach the end of the duty-cycle, start the next repeat test as soon as possible, allowing for the time needed to complete emission measurement and installation of new filters for PM measurement; in that case EF_H is the average emission level for the test segments that included regeneration.

(3) *Accounting for cold-start measurements.* For engines subject to cold-start testing requirements, incorporate cold-start operation into your analysis as follows:

(i) Determine the frequency of regeneration, *F,* in a way that incorporates the impact of cold-start operation in proportion to the cold-start weighting factor specified in the standard-setting part. You may use good engineering judgment to determine the effect of cold-start operation analytically.

(ii) Treat cold-start testing and hot-start testing together as a single test segment for adjusting measured emission results under this section.

Apply the adjustment factor to the composite emission result.

(iii) You may apply the adjustment factor only to the hot-start test result if your aftertreatment technology does not regenerate during cold operation as represented by the cold-start transient duty cycle. If we ask for it, you must demonstrate this by engineering analysis or by test data.

(c) If an engine has multiple regeneration strategies, determine and apply adjustment factors under this section separately for each type of regeneration.

■ 214. Section 1065.1005 is amended by revising paragraph (f)(2) to read as follows:

§ 1065.1005 Symbols, abbreviations, acronyms, and units of measure.

* * * * *

(f) * * *

(2) This part uses the following molar masses or effective molar masses of chemical species:

Symbol	Quantity	10^{-3}·kg·mol^{-1}
M_{air}	molar mass of dry air [1]	28.96559
M_{Ar}	molar mass of argon	39.948
M_{C}	molar mass of carbon	12.0107
M_{CH3OH}	molar mass of methanol	32.04186
M_{C2H5OH}	molar mass of ethanol	46.06844
M_{C2H4O}	molar mass of acetaldehyde	44.05256
M_{CH4N2O}	molar mass of urea	60.05526
M_{C3H8}	molar mass of propane	44.09562
M_{C3H7OH}	molar mass of propanol	60.09502
M_{CO}	molar mass of carbon monoxide	28.0101
M_{CH4}	molar mass of methane	16.0425
M_{CO2}	molar mass of carbon dioxide	44.0095
M_{H}	molar mass of atomic hydrogen	1.00794
M_{H2}	molar mass of molecular hydrogen	2.01588
M_{H2O}	molar mass of water	18.01528
M_{CH2O}	molar mass of formaldehyde	30.02598
M_{He}	molar mass of helium	4.002602
M_{N}	molar mass of atomic nitrogen	14.0067
M_{N2}	molar mass of molecular nitrogen	28.0134
M_{NH3}	molar mass of ammonia	17.03052
M_{NMHC}	effective C_1 molar mass of nonmethane hydrocarbon [2]	13.875389
M_{NMHCE}	effective C_1 molar mass of nonmethane hydrocarbon equivalent [2]	13.875389
M_{NOX}	effective molar mass of oxides of nitrogen [3]	46.0055
M_{N2O}	molar mass of nitrous oxide	44.0128
M_{O}	molar mass of atomic oxygen	15.9994
M_{O2}	molar mass of molecular oxygen	31.9988
M_{S}	molar mass of sulfur	32.065
M_{THC}	effective C_1 molar mass of total hydrocarbon [2]	13.875389
M_{THCE}	effective C_1 molar mass of total hydrocarbon equivalent [2]	13.875389

[1] See paragraph (f)(1) of this section for the composition of dry air.
[2] The effective molar masses of THC, THCE, NMHC, and NMHCE are defined on a C_1 basis and are based on an atomic hydrogen-to-carbon ratio, α, of 1.85 (with β, γ, and δ equal to zero).
[3] The effective molar mass of NO_X is defined by the molar mass of nitrogen dioxide, NO_2.

* * * * *

PART 1066—VEHICLE-TESTING PROCEDURES

■ 215. The authority citation for part 1066 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart C—Dynamometer Specifications

■ 216. Section 1066.210 is amended by revising paragraph (d)(3) to read as follows:

§ 1066.210 Dynamometers.

* * * * *

(d) * * *

(3) The load applied by the dynamometer simulates forces acting on the vehicle during normal driving according to the following equation:

$$FR_i = A \cdot \frac{100}{\sqrt{100^2 + G_i^2}} + B \cdot v_i + C \cdot v_i^2 + M_e \cdot \frac{v_i - v_{i-1}}{t_i - t_{i-1}} + M \cdot a_g \cdot \frac{G_i}{\sqrt{100^2 + G_i^2}} \quad \text{Eq. 1066.210-1}$$

Where:

FR = total road-load force to be applied at the surface of the roll. The total force is the sum of the individual tractive forces applied at each roll surface.

i = a counter to indicate a point in time over the driving schedule. For a dynamometer operating at 10-Hz intervals over a 600-second driving schedule, the maximum value of *i* should be 6,000.

A = a vehicle-specific constant value representing the vehicle's frictional load in lbf or newtons. See subpart D of this part.

G_i = instantaneous road grade, in percent (increase in elevation per 100 units horizontal length).

B = a vehicle-specific coefficient representing load from drag and rolling resistance, which are a function of vehicle speed, in lbf/mph or N·s/m. See subpart D of this part.

v = instantaneous linear speed at the roll surfaces as measured by the dynamometer, in mph or m/s. Let v_{i-1} = 0 for *i* = 0.

C = a vehicle-specific coefficient representing aerodynamic effects, which are a function of vehicle speed squared, in lbf/mph² or N·s²/m². See subpart D of this part.

M_e = the vehicle's effective mass in lbm or kg, including the effect of rotating axles as specified in § 1066.310(b)(7).
t = elapsed time in the driving schedule as measured by the dynamometer, in seconds. Let $t_{i-1} = 0$ for $i = 0$.
M = the measured vehicle mass, in lbm or kg.
a_g = acceleration of Earth's gravity, as described in 40 CFR 1065.630.

* * * * *

Subpart D—Coastdown

■ 217. Section 1066.301 is amended by adding introductory text to read as follows:

§ 1066.301 Overview of road-load determination procedures.

Vehicle testing on a chassis dynamometer involves simulating the road-load force, which is the sum of forces acting on a vehicle from aerodynamic drag, tire rolling resistance, driveline losses, and other effects of friction. Determine dynamometer settings to simulate road-load force in two stages. First, perform a road-load force specification by characterizing on-road operation. Second, perform a road-load derivation to determine the appropriate dynamometer load settings to simulate the road-load force specification from the on-road test.

* * * * *

■ 218. Section 1066.310 is amended by revising paragraphs (b)(7)(ii)(B) and (D) to read as follows:

§ 1066.310 Coastdown procedures for vehicles above 14,000 pounds GVWR.

* * * * *

(b) * * *

(7) * * *

(ii) * * *

(B) Calculate the vehicle's effective mass, M_e, in kg by adding 56.7 kg to the measured vehicle mass, M, for each tire making road contact. This accounts for the rotational inertia of the wheels and tires.

* * * * *

(D) Plot the data from all the coastdown runs on a single plot of F_i vs. v_i^2 to determine the slope correlation, D, based on the following equation:

$$F_i - M \cdot a_g \cdot \frac{\Delta h}{\Delta s} = A_m + D \cdot v_i^2 \qquad \text{Eq. 1066.310-2}$$

Where:
M = the measured vehicle mass, expressed to at least the nearest 0.1 kg.
a_g = acceleration of Earth's gravity, as described in 40 CFR 1065.630.
Δh = change in elevation over the measurement interval, in m. Assume $\Delta h = 0$ if you are not correcting for grade.
Δs = distance the vehicle travels down the road during the measurement interval, in m.
A_m = the calculated value of the y-intercept based on the curve-fit.

* * * * *

Subpart E—Preparing Vehicles and Running an Exhaust Emission Test

■ 219. Section 1066.410 is amended by revising paragraph (h) introductory text to read as follows:

§ 1066.410 Dynamometer test procedure.

* * * * *

(h) Determine equivalent test weight as follows:

* * * * *

Subpart G—Calculations

■ 220. Section 1066.605 is amended by redesignating paragraphs (d) through (g) as paragraphs (e) through (h), respectively and adding a new paragraph (d) to read as follows:

§ 1066.605 Mass-based and molar-based exhaust emission calculations.

* * * * *

(d) Calculate g/mile emission rates using the following equation unless specified otherwise in the standard-setting part:

$$e_{[emission]} = \frac{m_{[emission]}}{D}$$

Where:
$e_{[emission]}$ = emission rate over the test interval.
$m_{[emission]}$ = emission mass over the test interval.
D = the measured driving distance over the test interval.

Example:

$$m_{NOx} = 0.3177 \text{ g}$$

$$D_{HFET} = 10.19$$

$$e_{NOx} = \frac{0.3177}{10.19} = 0.0312 \text{ g/mi}$$

* * * * *

Subpart H—Cold Temperature Test Procedures

■ 221. Section 1066.710 is amended by revising paragraphs (a)(5) and (d)(3) introductory text to read as follows:

§ 1066.710 Cold temperature testing procedures for measuring CO and NMHC emissions and determining fuel economy.

* * * * *

(a) * * *

(5) Adjust the dynamometer to simulate vehicle operation on the road at −7 °C as described in § 1066.305(b)(2).

* * * * *

(d) * * *

(3) You may start the preconditioning drive once the fuel in the fuel tank reaches (–12.6 to –1.4) °C. Precondition the vehicle as follows:

* * * * *

Subpart I—Exhaust Emission Test Procedures for Motor Vehicles

■ 222. Section 1066.815 is amended by revising paragraph (b) introductory text to read as follows:

§ 1066.815 Exhaust emission test procedures for FTP testing.

* * * * *

(b) *PM sampling options.* Collect PM using any of the procedures specified in paragraphs (b)(1) through (5) of this section and use the corresponding equation in § 1066.820 to calculate FTP composite emissions. Testing must meet the requirements related to filter face velocity as described in 40 CFR 1065.170(c)(1)(vi), except as specified in paragraphs (b)(4) and (5) of this section. For procedures involving flow weighting, set the filter face velocity to a weighting target of 1.0 to meet the requirements of 40 CFR 1065.170(c)(1)(vi). Allow filter face velocity to decrease as a percentage of the weighting factor if the weighting factor is less than 1.0. Use the appropriate equations in § 1066.610 to show that you meet the dilution factor requirements of § 1066.110(b)(2)(iii)(B). If you collect PM using the procedures specified in paragraph (b)(4) or (b)(5) of this section, the residence time requirements in 40 CFR 1065.140(e)(3) apply, except that you may exceed an overall residence time of 5.5 s for sample flow rates below the highest expected sample flow rate.

* * * * *

PART 1068—GENERAL COMPLIANCE PROVISIONS FOR HIGHWAY, STATIONARY, AND NONROAD PROGRAMS

■ 223. The authority citation for part 1068 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart A—Applicability and Miscellaneous Provisions

■ 224. Section 1068.1 is revised to read as follows:

§ 1068.1 Does this part apply to me?

(a) The provisions of this part apply to everyone with respect to the engine and equipment categories as described in this paragraph (a). They apply to everyone, including owners, operators, parts manufacturers, and persons performing maintenance. Where we identify an engine category, the provisions of this part also apply with respect to the equipment using such engines. This part 1068 applies to different engine and equipment categories as follows:

(1) This part 1068 applies to motor vehicles we regulate under 40 CFR part 86, subpart S, to the extent and in the manner specified in 40 CFR parts 85 and 86.

(2) This part 1068 applies for heavy-duty motor vehicles certified under 40 CFR part 1037, subject to the provisions of 40 CFR parts 85 and 1037. This part 1068 applies to other heavy-duty motor vehicles and motor vehicle engines to the extent and in the manner specified in 40 CFR parts 85, 86, and 1036.

(3) This part 1068 applies to highway motorcycles we regulate under 40 CFR part 86, subparts E and F, to the extent and in the manner specified in 40 CFR parts 85 and 86.

(4) This part 1068 applies to aircraft we regulate under 40 CFR part 87 to the extent and in the manner specified in 40 CFR part 87.

(5) This part 1068 applies for locomotives that are subject to the provisions of 40 CFR part 1033. This part 1068 does not apply for locomotives or locomotive engines that were originally manufactured before July 7, 2008, and that have not been remanufactured on or after July 7, 2008.

(6) This part 1068 applies for land-based nonroad compression-ignition engines that are subject to the provisions of 40 CFR part 1039. This part 1068 does not apply for engines certified under 40 CFR part 89.

(7) This part 1068 applies for stationary compression-ignition engines certified using the provisions of 40 CFR parts 89, 94, 1039, and 1042 as described in 40 CFR part 60, subpart IIII.

(8) This part 1068 applies for marine compression-ignition engines that are subject to the provisions of 40 CFR part 1042. This part 1068 does not apply for marine compression-ignition engines certified under 40 CFR part 94.

(9) This part 1068 applies for marine spark-ignition engines that are subject to the provisions of 40 CFR part 1045. This part 1068 does not apply for marine spark-ignition engines certified under 40 CFR part 91.

(10) This part 1068 applies for large nonroad spark-ignition engines that are subject to the provisions of 40 CFR part 1048.

(11) This part 1068 applies for stationary spark-ignition engines certified using the provisions of 40 CFR part 1048 or part 1054, as described in 40 CFR part 60, subpart JJJJ.

(12) This part 1068 applies for recreational engines and vehicles, including snowmobiles, off-highway motorcycles, and all-terrain vehicles that are subject to the provisions of 40 CFR part 1051.

(13) This part applies for small nonroad spark-ignition engines that are subject to the provisions of 40 CFR part 1054. This part 1068 does not apply for nonroad spark-ignition engines certified under 40 CFR part 90.

(14) This part applies for fuel-system components installed in nonroad equipment powered by volatile liquid fuels that are subject to the provisions of 40 CFR part 1060.

(b) [Reserved]

(c) Paragraph (a) of this section identifies the parts of the CFR that define emission standards and other requirements for particular types of engines and equipment. This part 1068 refers to each of these other parts generically as the ‘‘standard-setting part.’’ For example, 40 CFR part 1051 is always the standard-setting part for snowmobiles. Follow the provisions of the standard-setting part if they are different than any of the provisions in this part.

(d) Specific provisions in this part 1068 start to apply separate from the schedule for certifying engines/equipment to new emission standards, as follows:

(1) The provisions of §§ 1068.30 and 1068.310 apply for stationary spark-ignition engines built on or after January 1, 2004, and for stationary compression-ignition engines built on or after January 1, 2006.

(2) The provisions of §§ 1068.30 and 1068.235 apply for the types of engines/equipment listed in paragraph (a) of this section beginning January 1, 2004, if they are used solely for competition.

(3) The standard-setting part may specify how the provisions of this part 1068 apply for uncertified engines/equipment.

■ 225. Section 1068.10 is amended by revising the section heading to read as follows:

§ 1068.10 Confidential information.

* * * * *

■ 226. Section 1068.15 is amended by revising the section heading and paragraph (a) to read as follows:

§ 1068.15 General provisions for EPA decision-making.

(a) Not all EPA employees may represent the Agency with respect to EPA decisions under this part or the standard-setting part. Only the Administrator of the Environmental Protection Agency or an official to whom the Administrator has delegated specific authority may represent the Agency. For more information, ask for a copy of the relevant sections of the EPA Delegations Manual from the Designated Compliance Officer.

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§ 1068.20—[Amended]

■ 227. Section 1068.20 is amended by removing paragraphs (b) and (c) and redesignating paragraphs (d) through (f) as paragraphs (b) through (d), respectively.

■ 228. Section 1068.27 is revised to read as follows:

§ 1068.27 May EPA conduct testing with my engines/equipment?

(a) As described in the standard-setting part, we may perform testing on your engines/equipment before we issue a certificate of conformity. This is generally known as confirmatory testing.

(b) If we request it, you must make a reasonable number of production-line engines or pieces of production-line equipment available for a reasonable time so we can test or inspect them for compliance with the requirements of this chapter.

(c) If your emission-data engine/equipment or production engine/equipment requires special components for proper testing, you must promptly provide any such components to us if we ask for them.

■ 229. Section 1068.30 is revised to read as follows:

§ 1068.30 Definitions.

The following definitions apply to this part. The definitions apply to all subparts unless we note otherwise. All undefined terms have the meaning the Clean Air Act gives to them. The definitions follow:

Affiliated companies or *affiliates* means one of the following:

(1) For determinations related to small manufacturer allowances or other small business provisions, these terms mean all entities considered to be affiliates with your entity under the Small Business Administration's regulations in 13 CFR 121.103.

(2) For all other provisions, these terms mean all of the following:

(i) Parent companies (as defined in this section).

(ii) Subsidiaries (as defined in this section).

(iii) Subsidiaries of your parent company.

Aftertreatment means relating to a catalytic converter, particulate filter, or any other system, component, or technology mounted downstream of the exhaust valve (or exhaust port) whose design function is to reduce emissions in the engine exhaust before it is exhausted to the environment. Exhaust-gas recirculation (EGR) is not aftertreatment.

Aircraft means any vehicle capable of sustained air travel more than 100 feet above the ground.

Certificate holder means a manufacturer (including importers) with a valid certificate of conformity for at least one family in a given model year, or the preceding model year. Note that only manufacturers may hold certificates. Your applying for or accepting a certificate is deemed to be your agreement that you are a manufacturer.

Clean Air Act means the Clean Air Act, as amended, 42 U.S.C. 7401–7671q.

Date of manufacture means one of the following:

(1) For engines, the date on which the crankshaft is installed in an engine block, with the following exceptions:

(i) For engines produced by secondary engine manufacturers under § 1068.262, date of manufacture means the date the engine is received from the original engine manufacturer. You may assign an earlier date up to 30 days before you received the engine, but not before the crankshaft was installed. You may not assign an earlier date if you cannot demonstrate the date the crankshaft was installed.

(ii) Manufacturers may assign a date of manufacture at a point in the assembly process later than the date otherwise specified under this definition. For example, a manufacturer may use the build date printed on the label or stamped on the engine as the date of manufacture.

(2) For equipment, the date on which the engine is installed, unless otherwise specified in the standard-setting part. Manufacturers may alternatively assign a date of manufacture later in the assembly process.

Days means calendar days, including weekends and holidays.

Defeat device has the meaning given in the standard-setting part.

Designated Compliance Officer means one of the following:

(1) For motor vehicles regulated under 40 CFR part 86, subpart S: Director, Light-Duty Vehicle Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *complianceinfo@epa.gov; epa.gov/otaq/verify*.

(2) For compression-ignition engines used in heavy-duty highway vehicles regulated under 40 CFR part 86, subpart A, and 40 CFR parts 1036 and 1037, and for nonroad and stationary compression-ignition engines or equipment regulated under 40 CFR parts 60, 1033, 1039, and 1042: Director, Diesel Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *complianceinfo@epa.gov*; *epa.gov/otaq/verify*.

(3) Director, Gasoline Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *nonroad-si-cert@epa.gov*; *epa.gov/otaq/verify*, for all the following engines and vehicles:

(i) For spark-ignition engines used in heavy-duty highway vehicles regulated under 40 CFR part 86, subpart A, and 40 CFR parts 1036 and 1037,

(ii) For highway motorcycles regulated under 40 CFR part 86, subpart E.

(iii) For nonroad and stationary spark-ignition engines or equipment regulated under 40 CFR parts 60, 1045, 1048, 1051, 1054, and 1060.

Engine means an engine block with an installed crankshaft, or a gas turbine engine. The term engine does not include engine blocks without an installed crankshaft, nor does it include any assembly of reciprocating engine components that does not include the engine block. (**Note:** For purposes of this definition, any component that is the primary means of converting an engine's energy into usable work is considered a crankshaft, whether or not it is known commercially as a crankshaft.) This includes complete and partially complete engines as follows:

(1) A complete engine is a fully assembled engine in its final configuration. In the case of equipment-based standards, an engine is not considered complete until it is installed in the equipment, even if the engine itself is fully assembled.

(2) A partially complete engine is an engine that is not fully assembled or is not in its final configuration. Except where we specify otherwise in this part or the standard-setting part, partially complete engines are subject to the same standards and requirements as complete engines. The following would be considered examples of partially complete engines:

(i) An engine that is missing certain emission-related components.

(ii) A new engine that was originally assembled as a motor-vehicle engine that will be recalibrated for use as a nonroad engine.

(iii) A new engine that was originally assembled as a land-based engine that will be modified for use as a marine propulsion engine.

(iv) A short block consisting of a crankshaft and other engine components connected to the engine block, but missing the head assembly.

(v) A long block consisting of all engine components except the fuel system and an intake manifold.

(vi) In the case of equipment-based standards, a fully functioning engine that is not yet installed in the equipment. For example, a fully functioning engine that will be installed in an off-highway motorcycle or a locomotive is considered partially complete until it is installed in the equipment.

Engine-based standard means an emission standard expressed in units of grams of pollutant per kilowatt-hour (or grams of pollutant per horsepower-hour) that applies to the engine. Emission standards are either engine-based or equipment-based. Note that engines may be subject to additional standards such as smoke standards.

Engine-based test means an emission test intended to measure emissions in units of grams of pollutant per kilowatt-hour (or grams of pollutant per horsepower-hour), without regard to whether the standard applies to the engine or equipment. Note that some products that are subject to engine-based testing are subject to additional test requirements such as for smoke.

Engine configuration means a unique combination of engine hardware and calibration within an engine family. Engines within a single engine configuration differ only with respect to normal production variability or factors unrelated to emissions.

Engine/equipment and *engines/equipment* mean engine(s) and/or equipment depending on the context. Specifically these terms mean the following:

(1) Engine(s) when only engine-based standards apply.

(2) Engine(s) for testing issues when engine-based testing applies.

(3) Engine(s) and equipment when both engine-based and equipment-based standards apply.

(4) Equipment when only equipment-based standards apply.

(5) Equipment for testing issues when equipment-based testing applies.

Equipment means one of the following things:

(1) Any vehicle, vessel, or other type of equipment that is subject to the requirements of this part or that uses an engine that is subject to the requirements of this part. An installed engine is part of the equipment.

(2) Fuel-system components that are subject to an equipment-based standard under this chapter. Installed fuel-system components are also considered part of the engine/equipment to which they are attached.

Equipment-based standard means an emission standard that applies to the equipment in which an engine is used or to fuel-system components associated with an engine, without regard to how the emissions are measured. If equipment-based standards apply, we require that the equipment or fuel-system components be certified rather than just the engine. Emission standards are either engine-based or equipment-based. For example, recreational vehicles we regulate under 40 CFR part 1051 are subject to equipment-based standards even if emission measurements are based on engine operation alone.

Excluded engines/equipment means engines/equipment that are not subject to emission standards or other requirements because they do not meet the definitions or other regulatory provisions that define applicability. For example, a non-stationary engine that is used solely for off-highway competition is excluded from the requirements of this part because it meets neither the definition of ''motor vehicle engine'' nor ''nonroad engine'' under section 216 of the Clean Air Act.

Exempted means relating to engines/equipment that are not required to meet otherwise applicable standards. Exempted engines/equipment must conform to regulatory conditions specified for an exemption in this part 1068 or in the standard-setting part. Exempted engines/equipment are deemed to be ''subject to'' the standards of the standard-setting part even though they are not required to comply with the otherwise applicable requirements. Engines/equipment exempted with respect to a certain tier of standards may be required to comply with an earlier tier of standards as a condition of the exemption; for example, engines exempted with respect to Tier 3 standards may be required to comply with Tier 1 or Tier 2 standards.

Family means engine family or emission family, as applicable under the standard-setting part.

Final deteriorated test result has the meaning given in the standard-setting part. If it is not defined in the standard-setting part, it means the emission level that results from applying all appropriate adjustments (such as deterioration factors) to the measured emission result of the emission-data engine.

Gas turbine engine means anything commercially known as a gas turbine engine or any collection of assembled engine components that is substantially similar to engines commercially known as gas turbine engines. For example, a jet engine is a gas turbine engine. Gas turbine engines may be complete or partially complete. Turbines that rely on external combustion such as steam engines are not gas turbine engines.

Good engineering judgment means judgments made consistent with generally accepted scientific and engineering principles and all available relevant information. See § 1068.5.

Manufacturer has the meaning given in section 216(1) of the Clean Air Act (42 U.S.C. 7550(1)). In general, this term includes any person who manufactures or assembles an engine or piece of equipment for sale in the United States or otherwise introduces a new engine or piece of equipment into U.S. commerce. This includes importers that import new engines or new equipment into the United States for resale. It also includes secondary engine manufacturers.

Model year has the meaning given in the standard-setting part. Unless the standard-setting part specifies otherwise, model year for individual engines/equipment is based on the date of manufacture or a later stage in the assembly process determined by the manufacturer, subject to the limitations described in §§ 1068.103 and 1068.360. The model year of a new engine that is neither certified nor exempt is deemed to be the calendar year in which it is sold, offered for sale, imported, or delivered or otherwise introduced into U.S. commerce.

Motor vehicle has the meaning given in 40 CFR 85.1703(a).

New has the meaning we give it in the standard-setting part. Note that in certain cases, used and remanufactured engines/equipment may be ''new'' engines/equipment.

Nonroad engine means:

(1) Except as discussed in paragraph (2) of this definition, a nonroad engine is an internal combustion engine that meets any of the following criteria:

(i) It is (or will be) used in or on a piece of equipment that is self-propelled or serves a dual purpose by both propelling itself and performing another function (such as garden tractors, off-highway mobile cranes and bulldozers).

(ii) It is (or will be) used in or on a piece of equipment that is intended to be propelled while performing its function (such as lawnmowers and string trimmers).

(iii) By itself or in or on a piece of equipment, it is portable or transportable, meaning designed to be and capable of being carried or moved from one location to another. Indicia of transportability include, but are not limited to, wheels, skids, carrying handles, dolly, trailer, or platform.

(2) An internal combustion engine is not a nonroad engine if it meets any of the following criteria:

(i) The engine is used to propel a motor vehicle, an aircraft, or equipment used solely for competition.

(ii) The engine is regulated under 40 CFR part 60, (or otherwise regulated by a federal New Source Performance Standard promulgated under section 111 of the Clean Air Act (42 U.S.C. 7411)). Note that this criterion does not apply for engines meeting any of the criteria of paragraph (1) of this definition that are voluntarily certified under 40 CFR part 60.

(iii) The engine otherwise included in paragraph (1)(iii) of this definition remains or will remain at a location for more than 12 consecutive months or a shorter period of time for an engine located at a seasonal source. A location is any single site at a building, structure, facility, or installation. For any engine (or engines) that replaces an engine at a location and that is intended to perform the same or similar function as the engine replaced, include the time period of both engines in calculating the consecutive time period. An engine located at a seasonal source is an engine that remains at a seasonal source during the full annual operating period of the seasonal source. A seasonal source is a stationary source that remains in a single location on a permanent basis (*i.e.*, at least two years) and that operates at that single location approximately three months (or more) each year. See § 1068.31 for provisions that apply if the engine is removed from the location.

Operating hours means:

(1) For engine and equipment storage areas or facilities, times during which people other than custodians and security personnel are at work near, and can access, a storage area or facility.

(2) For other areas or facilities, times during which an assembly line operates or any of the following activities occurs:

(i) Testing, maintenance, or service accumulation.

(ii) Production or compilation of records.

(iii) Certification testing.

(iv) Translation of designs from the test stage to the production stage.

(v) Engine or equipment manufacture or assembly.

Parent company means any entity that has a controlling ownership of another company. Note that the standard-setting part may treat a partial owner as a parent company even if it does not have controlling ownership of a company.

Piece of equipment means any vehicle, vessel, locomotive, aircraft, or other type of equipment equipped with engines to which this part applies.

Placed into service means used for its intended purpose. Engines/equipment do not qualify as being ''placed into service'' based on incidental use by a manufacturer or dealer.

Reasonable technical basis means information that would lead a person familiar with engine design and function to reasonably believe a conclusion related to compliance with the requirements of this part. For example, it would be reasonable to believe that parts performing the same function as the original parts (and to the same degree) would control emissions to the same degree as the original parts. Note that what is a reasonable basis for a person without technical training might not qualify as a reasonable technical basis.

Relating to as used in this section means relating to something in a specific, direct manner. This expression is used in this section only to define terms as adjectives and not to broaden the meaning of the terms. Note that ''relating to'' is used in the same manner as in the standard-setting parts.

Replacement engine means an engine exempted as a replacement engine under § 1068.240.

Revoke means to terminate the certificate or an exemption for a family. If we revoke a certificate or exemption, you must apply for a new certificate or exemption before continuing to introduce the affected engines/equipment into U.S. commerce. This does not apply to engines/equipment you no longer possess.

Secondary engine manufacturer means anyone who produces a new engine by modifying a complete or partially complete engine that was made by a different company. For the purpose of this definition, ''modifying'' does not include making changes that do not remove an engine from its original certified configuration. Secondary engine manufacturing includes, for example, converting automotive engines for use in industrial applications, or land-based engines for use in marine applications. This applies whether it involves a complete or partially complete engine and whether the engine was previously certified to emission standards or not.

(1) Manufacturers controlled by the manufacturer of the base engine (or by an entity that also controls the manufacturer of the base engine) are not secondary engine manufacturers; rather, both entities are considered to be one manufacturer for purposes of this part.

(2) This definition applies equally to equipment manufacturers that modify engines. Also, equipment manufacturers that certify to equipment-based standards using engines produced by another company are deemed to be secondary engine manufacturers.

(3) Except as specified in paragraph (2) of this definition, companies importing complete engines into the United States are not secondary engine manufacturers regardless of the procedures and relationships between companies for assembling the engines.

Small business means either of the following:

(1) A company that qualifies under the standard-setting part for special provisions for small businesses or small-volume manufacturers.

(2) A company that qualifies as a small business under the regulations adopted by the Small Business Administration at 13 CFR 121.201 if the standard-setting part does not establish such qualifying criteria.

Standard-setting part means a part in the Code of Federal Regulations that defines emission standards for a particular engine and/or piece of equipment (see § 1068.1(a)). For example, the standard-setting part for marine spark-ignition engines is 40 CFR part 1045. For provisions related to evaporative emissions, the standard-setting part may be 40 CFR part 1060, as specified in 40 CFR 1060.1.

Subsidiary means an entity that is owned or controlled by a parent company.

Suspend means to temporarily discontinue the certificate or an exemption for a family. If we suspend a certificate, you may not sell, offer for sale, or introduce or deliver into commerce in the United States or import into the United States engines/equipment from that family unless we reinstate the certificate or approve a new one. This also applies if we suspend an exemption, unless we reinstate the exemption.

Ultimate purchaser means the first person who in good faith purchases a new engine or new piece of equipment for purposes other than resale.

United States, in a geographic sense, means the States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, and the U.S. Virgin Islands.

U.S.-directed production volume has the meaning given in the standard-setting part.

Void means to invalidate a certificate or an exemption *ab initio* (''from the beginning''). If we void a certificate, all the engines/equipment introduced into U.S. commerce under that family for that model year are considered uncertified (or nonconforming) and are therefore not covered by a certificate of conformity, and you are liable for all engines/equipment introduced into U.S. commerce under the certificate and may face civil or criminal penalties or both. This applies equally to all engines/equipment in the family, including engines/equipment introduced into U.S. commerce before we voided the certificate. If we void an exemption, all the engines/equipment introduced into U.S. commerce under that exemption are considered uncertified (or nonconforming), and you are liable for engines/equipment introduced into U.S. commerce under the exemption and may face civil or criminal penalties or both. You may not sell, offer for sale, or introduce or deliver into commerce in the United States or import into the United States any additional engines/equipment using the voided exemption.

Voluntary emission recall means a repair, adjustment, or modification program voluntarily initiated and conducted by a manufacturer to remedy any emission-related defect for which engine owners have been notified.

We (us, our) means the Administrator of the Environmental Protection Agency and any authorized representatives.

■ 230. Section 1068.31 is amended by revising the section heading, the introductory text, and paragraph (c) to read as follows:

§ 1068.31 Changing the status of nonroad or stationary engines under the definition of ''nonroad engine''.

This section specifies the provisions that apply when an engine previously used in a nonroad application is subsequently used in an application other than a nonroad application, or when an engine previously used in a stationary application (*i.e.*, an engine that was not used as a nonroad engine and that was not used to propel a motor vehicle, an aircraft, or equipment used solely for competition) is moved.

* * * * *

(c) A stationary engine does not become a new nonroad engine if it is moved but continues to meet the criteria specified in paragraph (2)(iii) in the definition of ''nonroad engine'' in § 1068.30 in its new location. For example, a transportable engine that is used in a single specific location for 18 months and is later moved to a second specific location where it will remain for at least 12 months is considered to be a stationary engine in both locations. Note that for stationary engines that are neither portable nor transportable in actual use, the residence-time restrictions in the definition of ''nonroad engine'' generally do not apply.

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■ 231. A new § 1068.32 is added to read as follows:

§ 1068.32 Explanatory terms.

This section explains how certain phrases and terms are used in 40 CFR parts 1000 through 1099, especially those used to clarify and explain regulatory provisions.

(a) *Types of provisions.* The term ''provision'' includes all aspects of the regulations. As described in this section, regulatory provisions include standards, requirements, prohibitions, and allowances, along with a variety of other types of provisions. In certain cases, we may use these terms to apply to some but not all of the provisions of a part or section. For example, we may apply the allowances of a section for certain engines, but not the requirements. We may also apply all provisions except the requirements and prohibitions.

(1) A standard is a requirement established by regulation that limits the emissions of air pollutants. Examples of standards include numerical emission standards (such as 0.01 g/kW-hr) and design standards (such a closed crankcase standard). Compliance with or conformance to a standard is a specific type of requirement, and in some cases a standard may be discussed as a requirement. Thus, a statement about the requirements of a part or section also applies with respect to the standards of the part or section.

(2) The regulations apply other requirements in addition to standards. For example, manufacturers are required to keep records and provide reports to EPA.

(3) While requirements state what someone must do, prohibitions state what someone may not do. Prohibitions are often referred to as prohibited acts or prohibited actions. Most penalties apply for violations of prohibitions. A list of prohibitions may therefore include the failure to meet a requirement as a prohibited action.

(4) Allowances provide some form of relief from requirements. This may include provisions delaying implementation, establishing exemptions or test waivers, or creating alternative compliance options. Allowances may be conditional. For example, we may exempt you from certain requirements on the condition that you meet certain other requirements.

(5) The regulations also include important provisions that are not standards, requirements, prohibitions, or allowances, such as definitions.

(6) Engines/equipment are generally considered ''*subject to*'' a specific provision if that provision applies, or if it does not apply because of an exemption authorized under the regulation. For example, locomotives are subject to the provisions of 40 CFR part 1033 even if they are exempted from the standards of part 1033.

(b) *Singular and plural.* Unless stated otherwise or unless it is clear from the regulatory context, provisions written in singular form include the plural form and provisions written in plural form include the singular form. For example, the statement ''The manufacturer must keep this report for three years'' is equivalent to ''The manufacturers must keep these reports for three years.''

(c) *Inclusive lists.* Lists in the regulations prefaced by ''including'' or ''this includes'' are not exhaustive. The terms ''including'' and ''this includes'' should be read to mean ''including but not limited to'' and ''this includes but is not limited to''. For example, the phrase ''including small manufacturers'' does not exclude large manufacturers. However, prescriptive statements to ''include'' specific items (such as those related to recordkeeping and reporting requirements) may be exhaustive.

(d) *Notes.* Statements that begin with ''**Note:**'' or ''Note that'' are intended to clarify specific regulatory provisions stated elsewhere in the regulations. By themselves, such statements are not intended to specify regulatory requirements. Such statements are typically used for regulatory text that, while legally sufficient to specify a requirement, may be misunderstood by some readers. For example, the regulations might note that a word is defined elsewhere in the regulations to have a specific meaning that may be either narrower or broader than some readers might assume.

(e) *Examples.* Examples provided in the regulations are typically introduced by either ''for example'' or ''such as''. Specific examples given in the regulations do not necessarily represent the most common examples. The regulations may specify examples conditionally (that is, specifying that they are applicable only if certain criteria or conditions are met). Lists of examples cannot be presumed to be exhaustive lists.

(f) *Generally and typically.* Statements that begin with ''generally'', ''in general'', or ''typically'' should not be read to apply universally or absolutely. Rather they are intended to apply for the most common circumstances. ''Generally'' and ''typically'' statements may be identified as notes as described in paragraph (d) of this section.

(g) *Unusual circumstances.* The regulations specify certain allowances that apply ''in unusual circumstances''. While it is difficult to precisely define what ''unusual circumstances'' means, this generally refers to specific circumstances that are both rare and unforeseeable. For example, a severe hurricane in the northeastern United States may be considered to be an unusual circumstance, while a less severe hurricane in the southeastern United States may not be. Where the regulations limit an allowance to unusual circumstances, manufacturers and others should not presume that such an allowance will be available to them. Provisions related to unusual circumstances may be described using the phrase ''normal circumstances'', which are those circumstances that are not unusual circumstances.

(h) *Exceptions and other specifications.* Regulatory provisions may be expressed as a general prohibition, requirement, or allowance that is modified by other regulatory text. Such provisions may include phrases such as ''unless specified otherwise'', ''except as specified'', or ''as specified in this section''. It is important that the exceptions and the more general statement be considered together. This regulatory construct is intended to allow the core requirement or allowance to be stated in simple, clear sentences, rather than more precise and comprehensive sentences that may be misread. For example, where an action is prohibited in most but not all circumstances, the provision may state that you may not take the action, ''except as specified in this section.'' The exceptions could then be stated in subsequent regulatory text.

■ 232. Section 1068.35 is amended by revising the section heading to read as follows:

§ 1068.35 Symbols, acronyms, and abbreviations.

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■ 233. Section 1068.40 is amended by revising the section heading and paragraph (a) and removing paragraph (c).

The revisions read as follows:

§ 1068.40 Special provisions for implementing changes in the regulations.

(a) During the 12 months following the effective date of any change in the provisions of this part, you may ask to apply the previously applicable provisions. Note that the effective date is generally 30 or 60 days after publication in the **Federal Register**, as noted in the final rule. We will generally approve your request if you can demonstrate that it would be impractical to comply with the new requirements. We may consider the potential for adverse environmental impacts in our decision. Similarly, in unusual circumstances, you may ask for relief under this paragraph (a) from new requirements that apply under the standard-setting part.

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■ 234. Section 1068.45 is amended by revising paragraph (e) and adding paragraphs (g) and (h) to read as follows:

§ 1068.45 General labeling provisions.

* * * * *

(e) *Prohibitions against removing labels.* As specified in § 1068.101(b)(7), removing permanent labels is prohibited except for certain circumstances. Removing temporary or removable labels prematurely is also prohibited by § 1068.101(b)(7).

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(g) *Date format.* If you use a coded approach to identify the engine/equipment's date of manufacture, describe or interpret the code in your application for certification.

(h) *Branding.* The following provisions apply if you identify the name and trademark of another company instead of your own on your emission control information label, as provided in the standard-setting part:

(1) You must have a contractual agreement with the other company that obligates that company to take the following steps:

(i) Meet the emission warranty requirements that apply under the standard-setting part. This may involve a separate agreement involving reimbursement of warranty-related expenses.

(ii) Report all warranty-related information to the certificate holder.

(2) In your application for certification, identify the company whose trademark you will use.

(3) You remain responsible for meeting all the requirements of this chapter, including warranty and defect-reporting provisions.

■ 235. Section 1068.95 is revised to read as follows:

§ 1068.95 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, a document must be published in the **Federal Register** and the material must be available to the public. All approved materials are available for inspection at the Air and Radiation Docket and Information Center (Air Docket) in the EPA Docket Center (EPA/DC) at Rm. 3334, EPA West Bldg., 1301 Constitution Ave. NW., Washington, DC. The EPA/DC Public Reading Room hours of operation are 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number of the EPA/DC Public Reading Room is (202) 566–1744, and the telephone number for the Air Docket is (202) 566–1742. These approved materials are also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call (202) 741–6030 or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*. In addition, these materials are available from the sources listed below.

(b) SAE International, 400 Commonwealth Dr., Warrendale, PA 15096–0001, (724) 776–4841, or *http://www.sae.org*:

(1) SAE J1930, Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms, revised April 2002 (''SAE J1930''), IBR approved for § 1068.45(f).

(2) [Reserved]

Subpart B—Prohibited Actions and Related Requirements

■ 236. Section 1068.101 is amended by revising the introductory text and paragraphs (a)(1), (b), and (h) introductory text to read as follows:

§ 1068.101 What general actions does this regulation prohibit?

This section specifies actions that are prohibited and the maximum civil penalties that we can assess for each violation in accordance with 42 U.S.C. 7522 and 7524. The maximum penalty values listed in paragraphs (a) and (b) of this section and in § 1068.125 apply as of December 7, 2013. As described in paragraph (h) of this section, these maximum penalty limits are different for earlier violations and they may be adjusted as set forth in 40 CFR part 19.

(a) * * *

(1) *Introduction into commerce.* You may not sell, offer for sale, or introduce

or deliver into commerce in the United States or import into the United States any new engine/equipment after emission standards take effect for the engine/equipment, unless it is covered by a valid certificate of conformity for its model year and has the required label or tag. You also may not take any of the actions listed in the previous sentence with respect to any equipment containing an engine subject to this part's provisions unless the engine is covered by a valid certificate of conformity for its model year and has the required engine label or tag. We may assess a civil penalty up to $37,500 for each engine or piece of equipment in violation.

(i) For purposes of this paragraph (a)(1), a valid certificate of conformity is one that applies for the same model year as the model year of the equipment (except as allowed by § 1068.105(a)), covers the appropriate category or subcategory of engines/equipment (such as locomotive or sterndrive/inboard Marine SI or nonhandheld Small SI), and conforms to all requirements specified for equipment in the standard-setting part. Engines/equipment are considered not covered by a certificate unless they are in a configuration described in the application for certification.

(ii) The prohibitions of this paragraph (a)(1) also apply for new engines you produce to replace an older engine in a piece of equipment, except that the engines may qualify for the replacement-engine exemption in § 1068.240.

(iii) The prohibitions of this paragraph (a)(1) also apply for new engines that will be installed in equipment subject to equipment-based standards, except that the engines may qualify for an exemption under § 1068.260(c) or § 1068.262.

(iv) Where the regulations specify that you are allowed to introduce engines/equipment into U.S. commerce without a certificate of conformity, you may take any of the otherwise prohibited actions specified in this paragraph (a)(1) with respect to those engines/equipment.

* * * * *

(b) The following prohibitions apply to everyone with respect to the engines and equipment to which this part applies:

(1) *Tampering.* You may not remove or render inoperative any device or element of design installed on or in engines/equipment in compliance with the regulations prior to its sale and delivery to the ultimate purchaser. You also may not knowingly remove or render inoperative any such device or element of design after such sale and delivery to the ultimate purchaser. This includes, for example, operating an engine without a supply of appropriate quality urea if the emission control system relies on urea to reduce NO_X emissions or the use of incorrect fuel or engine oil that renders the emissions control system inoperative. Section 1068.120 describes how this applies to rebuilding engines. See the standard-setting part, which may include additional provisions regarding actions prohibited by this requirement. For a manufacturer or dealer, we may assess a civil penalty up to $37,500 for each engine or piece of equipment in violation. For anyone else, we may assess a civil penalty up to $3,750 for each engine or piece of equipment in violation. This prohibition does not apply in any of the following situations:

(i) You need to repair the engine/equipment and you restore it to proper functioning when the repair is complete.

(ii) You need to modify the engine/equipment to respond to a temporary emergency and you restore it to proper functioning as soon as possible.

(iii) You modify new engines/equipment that another manufacturer has already certified to meet emission standards and recertify them under your own family. In this case you must tell the original manufacturer not to include the modified engines/equipment in the original family.

(2) *Defeat devices.* You may not knowingly manufacture, sell, offer to sell, or install, any component that bypasses, impairs, defeats, or disables the control of emissions of any regulated pollutant, except as explicitly allowed by the standard-setting part. We may assess a civil penalty up to $3,750 for each component in violation.

(3) *Stationary engines.* For an engine that is excluded from any requirements of this chapter because it is a stationary engine, you may not move it or install it in any mobile equipment except as allowed by the provisions of this chapter. You may not circumvent or attempt to circumvent the residence-time requirements of paragraph (2)(iii) of the nonroad engine definition in § 1068.30. Anyone violating this paragraph (b)(3) is deemed to be a manufacturer in violation of paragraph (a)(1) of this section. We may assess a civil penalty up to $37,500 for each engine or piece of equipment in violation.

(4) *Competition engines/equipment.* (i) For uncertified engines/equipment that are excluded or exempted as new engines/equipment from any requirements of this chapter because they are to be used solely for competition, you may not use any of them in a manner that is inconsistent with use solely for competition. Anyone violating this paragraph (b)(4)(i) is deemed to be a manufacturer in violation of paragraph (a)(1) of this section. We may assess a civil penalty up to $37,500 for each engine or piece of equipment in violation.

(ii) For certified nonroad engines/equipment that qualify for exemption from the tampering prohibition as described in § 1068.235 because they are to be used solely for competition, you may not use any of them in a manner that is inconsistent with use solely for competition. Anyone violating this paragraph (b)(4)(ii) is in violation of paragraph (b)(1) or (2) of this section. Certified motor vehicles and motor vehicle engines and their emission control devices must remain in their certified configuration even if they are used solely for competition or if they become nonroad vehicles or engines; anyone modifying a certified motor vehicle or motor vehicle engine for any reason is subject to the tampering and defeat device prohibitions of 40 CFR 1068.101(b) and 42 U.S.C. 7522(a)(3).

(5) *Importation.* You may not import an uncertified engine or piece of equipment if it is defined to be new in the standard-setting part with a model year for which emission standards applied. Anyone violating this paragraph (b)(5) is deemed to be a manufacturer in violation of paragraph (a)(1) of this section. We may assess a civil penalty up to $37,500 for each engine or piece of equipment in violation. Note the following:

(i) The definition of new is broad for imported engines/equipment; uncertified engines and equipment (including used engines and equipment) are generally considered to be new when imported.

(ii) Used engines/equipment that were originally manufactured before applicable EPA standards were in effect are generally not subject to emission standards.

(6) *Warranty, recall, and maintenance instructions.* You must meet your obligation to honor your emission-related warranty under § 1068.115, including any commitments you identify in your application for certification. You must also fulfill all applicable requirements under subpart F of this part related to emission-related defects and recalls. You must also provide emission-related installation and maintenance instructions as described in the standard-setting part. Failure to meet these obligations is prohibited. Also, except as specifically

provided by regulation, you are prohibited from directly or indirectly communicating to the ultimate purchaser or a later purchaser that the emission-related warranty is valid only if the owner has service performed at authorized facilities or only if the owner uses authorized parts, components, or systems. We may assess a civil penalty up to $37,500 for each engine or piece of equipment in violation.

(7) *Labeling.* (i) You may not remove or alter an emission control information label or other required permanent label except as specified in this paragraph (b)(7) or otherwise allowed by this chapter. Removing or altering an emission control information label is a violation of paragraph (b)(1) of this section. However, it is not a violation to remove a label in the following circumstances:

(A) The engine is destroyed, is permanently disassembled, or otherwise loses its identity such that the original title to the engine is no longer valid.

(B) The regulations specifically direct you to remove the label. For example, see § 1068.235.

(C) The part on which the label is mounted needs to be replaced. In this case, you must have a replacement part with a duplicate of the original label installed by the certifying manufacturer or an authorized agent, except that the replacement label may omit the date of manufacture if applicable. We generally require labels to be permanently attached to parts that will not normally be replaced, but this provision allows for replacements in unusual circumstances, such as damage in a collision or other accident.

(D) The original label is incorrect, provided that it is replaced with the correct label from the certifying manufacturer or an authorized agent. This allowance to replace incorrect labels does not affect whether the application of an incorrect original label is a violation.

(ii) Removing or altering a temporary or removable label contrary to the provisions of this paragraph (b)(7)(ii) is a violation of paragraph (b)(1) of this section.

(A) For labels identifying temporary exemptions, you may not remove or alter the label while the engine/equipment is in an exempt status. The exemption is automatically revoked for each engine/equipment for which the label has been removed.

(B) For temporary or removable consumer information labels, only the ultimate purchaser may remove the label.

(iii) You may not apply a false emission control information label. You also may not manufacture, sell, or offer to sell false labels. The application, manufacture, sale, or offer for sale of false labels is a violation of this section (such as paragraph (a)(1) or (b)(2) of this section). Note that applying an otherwise valid emission control information label to the wrong engine is considered to be applying a false label.

(iv) Information on engine/equipment labels as specified in this chapter is deemed to be information submitted to EPA and is therefore subject to the prohibition against knowingly submitting false information under paragraph (a)(2) of this section and 18 U.S.C. 1001.

* * * * *

(h) The maximum penalty values listed in paragraphs (a) and (b) of this section and in § 1068.125 apply as of December 7, 2013. Maximum penalty values for earlier violations are published in 40 CFR part 19. Maximum penalty limits may be adjusted after December 7, 2013 based on the Consumer Price Index. The specific regulatory provisions for changing the maximum penalties, published in 40 CFR part 19, reference the applicable U.S. Code citation on which the prohibited action is based. The following table is shown here for informational purposes:

* * * * *

■ 237. Section 1068.103 is revised to read as follows:

§ 1068.103 Provisions related to the duration and applicability of certificates of conformity.

(a) Engines/equipment covered by a certificate of conformity are limited to those that are produced during the period specified in the certificate and conform to the specifications described in the certificate and the associated application for certification. For the purposes of this paragraph (a), ''specifications'' includes the emission control information label and any conditions or limitations identified by the manufacturer or EPA. For example, if the application for certification specifies certain engine configurations, the certificate does not cover any configurations that are not specified. We may ignore any information provided in the application that we determine is not relevant to a demonstration of compliance with applicable regulations, such as your projected production volumes in many cases.

(b) Unless the standard-setting part specifies otherwise, determine the production period corresponding to each certificate of conformity as specified in this paragraph (b). In general, the production period is the manufacturer's annual production period identified as a model year.

(1) For engines/equipment subject to emission standards based on model years, the first day of the annual production period can be no earlier than January 2 of the calendar year preceding the year for which the model year is named, or the earliest date of manufacture for any engine/equipment in the engine family, whichever is later. The last day of the annual production period can be no later than December 31 of the calendar year for which the model year is named or the latest date of manufacture for any engine/equipment in the engine family, whichever is sooner. Note that this approach limits how you can designate a model year for your engines/equipment; however, it does not limit your ability to meet more stringent emission standards early where this is permitted in the regulation.

(2) For fuel-system components certified to evaporative emission standards based on production periods rather than model years, the production period is either the calendar year or a longer period we specify consistent with the manufacturer's normal production practices.

(c) A certificate of conformity will not cover engines/equipment you produce with a date of manufacture earlier than the date you submit the application for certification for the family. You may start to produce engines/equipment after you submit an application for certification and before the effective date of a certificate of conformity, subject to the following conditions:

(1) The engines/equipment must conform in all material respects to the engines/equipment described in your application. Note that if we require you to modify your application, you must ensure that all engines/equipment conform to the specifications of the modified application.

(2) The engines/equipment may not be sold, offered for sale, introduced into U.S. commerce, or delivered for introduction into U.S. commerce before the effective date of the certificate of conformity.

(3) You must notify us in your application for certification that you plan to use the provisions of this paragraph (c) and when you intend to start production. If the standard-setting part specifies mandatory testing for production-line engines, you must start testing as directed in the standard-setting part based on your actual start of production, even if that occurs before we approve your certification. You must also agree to give us full opportunity to inspect and/or test the engines/

equipment during and after production. For example, we must have the opportunity to specify selective enforcement audits as allowed by the standard-setting part and the Clean Air Act as if the engines/equipment were produced after the effective date of the certificate.

(4) See § 1068.262 for special provisions that apply for secondary engine manufacturers receiving shipment of partially complete engines before the effective date of a certificate.

(d) The prohibition in § 1068.101(a)(1) against offering to sell engines/equipment without a valid certificate of conformity generally does not apply for engines/equipment that have not yet been produced. You may contractually agree to produce engines/equipment before obtaining the required certificate of conformity. This is intended to allow manufacturers of low-volume products to establish a sufficient market for engines/equipment before going through the effort to certify.

(e) Engines/equipment with a date of manufacture after December 31 of the calendar year for which a model year is named are not covered by the certificate of conformity for that model year. You must submit an application for a new certificate of conformity demonstrating compliance with applicable standards even if the engines/equipment are identical to those built before December 31.

(f) The flexible approach to naming the annual production period described in paragraph (b)(1) of this section is intended to allow you to introduce new products at any point during the year. This is based on the expectation that production periods generally run on consistent schedules from year to year. You may not use this flexibility to arrange your production periods such that you can avoid annual certification.

(g) An engine is generally assigned a model year based on its date of manufacture, which is typically based on the date the crankshaft is installed in the engine (see § 1068.30). You may not circumvent the provisions of § 1068.101(a)(1) by stockpiling engines with a date of manufacture before new or changed emission standards take effect by deviating from your normal production and inventory practices. (For purposes of this paragraph (g), normal production and inventory practices means those practices you typically use for similar families in years in which emission standards do not change. We may require you to provide us routine production and inventory records that document your normal practices for the preceding eight years.) For most engines you should plan to complete the assembly of an engine of a given model year into its certified configuration within the first week after the end of the model year if new emission standards start to apply in that model year. For special circumstances it may be appropriate for your normal business practice to involve more time. For engines with per-cylinder displacement below 2.5 liters, if new emission standards start to apply in a given year, we would consider an engine not to be covered by a certificate of conformity for the preceding model year if the engine is not assembled in a compliant configuration within 30 days after the end of the model year for that engine family. (**Note:** an engine is considered ''in a compliant configuration'' without being fully assembled if § 1068.260(a) or (b) authorizes shipment of the engine without certain components.) For example, in the case where new standards apply in the 2010 model year, and your normal production period is based on the calendar year, you must complete the assembly of all your 2009 model year engines before January 31, 2010, or an earlier date consistent with your normal production and inventory practices. For engines with per-cylinder displacement at or above 2.5 liters, this time may not exceed 60 days. Note that for the purposes of this paragraph (g), an engine shipped under § 1068.261 is deemed to be a complete engine. Note also that § 1068.245 allows flexibility for additional time in unusual circumstances. Note finally that disassembly of complete engines and reassembly (such as for shipment) does not affect the determination of model year; the provisions of this paragraph (g) apply based on the date on which initial assembly is complete.

(h) This paragraph (h) describes the effect of suspending, revoking, or voiding a certificate of conformity. See the definitions of ''suspend,'' ''revoke,'' and ''void'' in § 1068.30. Engines/equipment produced at a time when the otherwise applicable certificate of conformity has been suspended or revoked are not covered by a certificate of conformity. Where a certificate of conformity is void, all engines/equipment produced under that certificate of conformity are not and were not covered by a certificate of conformity. In cases of suspension, engines/equipment will be covered by a certificate only if they are produced after the certificate is reinstated or a new certificate is issued. In cases of revocation and voiding, engines/equipment will be covered by a certificate only if they are produced after we issue a new certificate. 42 U.S.C. 7522(a)(1) and § 1068.101(a)(1) prohibit selling, offering for sale, introducing into commerce, delivering for introduction into commerce, and importing engines/equipment that are not covered by a certificate of conformity, and they prohibit anyone from causing another to violate these prohibitions.

(i) You may transfer a certificate to another entity only in the following cases:

(1) You may transfer a certificate to a parent company, including a parent company that purchases your company after we have issued your certificate.

(2) You may transfer a certificate to a subsidiary including a subsidiary you purchase after we have issued your certificate.

(3) You may transfer a certificate to a subsidiary of your parent company.

■ 238. Section 1068.105 is amended by revising paragraphs (a) and (c)(2) to read as follows:

§ 1068.105 What other provisions apply to me specifically if I manufacture equipment needing certified engines?

* * * * *

(a) *Transitioning to new engine-based standards.* If new engine-based emission standards apply in a given model year, your equipment produced in that calendar year (or later) must have engines that are certified to the new standards, except that you may continue to use up normal inventories of earlier engines that were built before the date of the new or changed standards. For purposes of this paragraph (a), normal inventory applies for engines you possess and engines from your engine supplier's normal inventory. (**Note:** this paragraph (a) does not apply in the case of new remanufacturing standards.) We may require you and your engine suppliers to provide us routine production and/or inventory records that document your normal practices for the preceding eight years. For example, if you have records documenting that your normal inventory practice is to keep on hand a one-month supply of engines based on your upcoming production schedules, and a new tier of standards starts to apply for the 2015 model year, you may order engines consistent with your normal inventory requirements late in the engine manufacturer's 2014 model year and install those engines in your equipment consistent with your normal production schedule. Also, if your model year starts before the end of the calendar year preceding new standards, you may use engines from the previous model year for those units you completely assemble before January 1 of the year that new standards apply. If emission standards for the engine do not change in a given model year, you may continue to install engines from the previous model year without restriction (or any earlier model year for which the same standards apply). You may not circumvent the provisions of § 1068.101(a)(1) by stockpiling engines that were built before new or changed standards take effect. Similarly, you may not circumvent the provisions of § 1068.101(a)(1) by knowingly installing engines that were stockpiled by engine suppliers in violation of § 1068.103(f). Note that this allowance does not apply for equipment subject to equipment-based standards. See 40 CFR 1060.601 for similar provisions that apply for equipment subject to evaporative emission standards. Note that the standard-setting part may impose further restrictions on using up inventories of engines from an earlier model year under this paragraph (a).

* * * * *

(c) * * *

(2) Permanently attach the duplicate label to your equipment by securing it to a part needed for normal operation and not normally requiring replacement. Make sure an average person can easily read it. Note that attaching an inaccurate duplicate label may be a violation of § 1068.101(b)(7).

* * * * *

■ 239. Section 1068.110 is amended by revising the section heading and paragraph (d) to read as follows:

§ 1068.110 Other provisions for engines/equipment in service.

* * * * *

(d) *Defeat devices.* We may test components, engines, and equipment to investigate potential defeat devices. We may also require the manufacturer to do this testing. If we choose to investigate one of your designs, we may require you to show us that a component is not a defeat device, and that an engine/equipment does not have a defeat device. To do this, you may have to share with us information regarding test programs, engineering evaluations, design specifications, calibrations, on-board computer algorithms, and design strategies. It is a violation of the Clean Air Act for anyone to make, install or use defeat devices as described in § 1068.101(b)(2) and the standard-setting part.

* * * * *

■ 240. Section 1068.115 is amended by revising the section heading to read as follows:

§ 1068.115 What are manufacturers' emission-related warranty requirements?

* * * * *

■ 241. Section 1068.120 is amended by revising the section heading and paragraph (f) to read as follows:

§ 1068.120 Requirements for rebuilding engines.

* * * * *

(f) A rebuilt engine or other used engine may replace a certified engine in a piece of equipment only if the engine was built and/or rebuilt to a certified configuration meeting equivalent or more stringent emission standards. Note that a certified configuration would generally include more than one model year. A rebuilt engine being installed that is from the same model year or a newer model year than the engine being replaced meets this requirement. The following examples illustrate the provisions of this paragraph (f):

(1) In most cases, you may use a rebuilt Tier 2 engine to replace a Tier 1 engine or another Tier 2 engine.

(2) You may use a rebuilt Tier 1 engine to replace a Tier 2 engine if the two engines differ only with respect to model year or other characteristics unrelated to emissions since such engines would be considered to be in the same configuration. This may occur if the Tier 1 engine had emission levels below the Tier 2 standards or if the Tier 2 engine was certified with a Family Emission Limit for calculating emission credits.

(3) You may use a rebuilt engine that originally met the Tier 1 standards without certification, as provided under § 1068.265, to replace a certified Tier 1 engine. This may occur for engines produced under a Transition Program for Equipment Manufacturers such as that described in 40 CFR 1039.625.

(4) You may never replace a certified engine with an engine rebuilt to a configuration that does not meet EPA emission standards. Note that, for purposes of this paragraph (f)(4), a configuration is considered to meet EPA emission standards if it was previously certified or was otherwise shown to meet emission standards (see § 1068.265).

* * * * *

■ 242. Section 1068.125 is amended by revising paragraph (b) introductory text to read as follows:

§ 1068.125 What happens if I violate the regulations?

* * * * *

(b) *Administrative penalties.* Instead of bringing a civil action, we may assess administrative penalties if the total is less than $320,000 against you individually. This maximum penalty may be greater if the Administrator and the Attorney General jointly determine that a greater administrative penalty assessment is appropriate, or if the limit is adjusted under 40 CFR part 19. No court may review this determination. Before we assess an administrative penalty, you may ask for a hearing as described in subpart G of this part. The Administrator may compromise or remit, with or without conditions, any administrative penalty that may be imposed under this section.

* * * * *

Subpart C— Exemptions and Exclusions

■ 243. Section 1068.201 is amended by revising the section heading and paragraphs (a), (c), and (i) to read as follows:

§ 1068.201 General exemption and exclusion provisions.

* * * * *

(a) This subpart identifies which engines/equipment qualify for exemptions and what information we need. We may require more information.

* * * * *

(c) If you use an exemption under this subpart, we may require you to add a permanent or temporary label to your exempted engines/equipment. You may ask us to modify these labeling requirements if it is appropriate for your engine/equipment.

* * * * *

(i) If you want to take an action with respect to an exempted or excluded engine/equipment that is prohibited by the exemption or exclusion, such as selling it, you need to certify the engine/equipment or qualify for a different exemption.

(1) We will issue a certificate of conformity if you send us an application for certification showing that you meet all the applicable requirements from the standard-setting part and pay the appropriate fee. Alternatively, we may allow you to include in an existing certified engine family those engines/equipment you modify (or otherwise demonstrate) to be identical to engines/equipment already covered by the certificate. We would base such an approval on our review of any appropriate documentation. These engines/equipment must have emission control information labels that accurately describe their status.

(2) The exemption provisions of this part may be applied to new engines without regard to whether or not they have already been certified or exempted. You may ask to apply the exemption

provisions prospectively to used engines to cover circumstances not otherwise allowed by the original certification or exemption. Note that application of new exemption provisions does not apply with respect to actions that occur before the new exemption applies. For example, you may ask for a testing exemption for a new or used engine that has already been introduced into commerce under a competition exemption, but the testing exemption would not cover non-competition use that occurred before we approved the testing exemption.

■ 244. Section 1068.210 is amended by revising the section heading and paragraph (e) to read as follows:

§ 1068.210 Exempting test engines/equipment.

* * * * *

(e) If we approve your request for a testing exemption, we will send you a letter or a memorandum describing the basis and scope of the exemption. It will also include any necessary terms and conditions, which normally require you to do the following:

(1) Stay within the scope of the exemption.

(2) Create and maintain adequate records that we may inspect.

(3) Add a permanent label to all engines/equipment exempted under this section, consistent with § 1068.45, with at least the following items:

(i) The label heading ''EMISSION CONTROL INFORMATION''.

(ii) Your corporate name and trademark.

(iii) Engine displacement, family identification, and model year of the engine/equipment (as applicable), or whom to contact for further information.

(iv) The statement: ''THIS [engine, equipment, vehicle, etc.] IS EXEMPT UNDER 40 CFR 1068.210 OR 1068.215 FROM EMISSION STANDARDS AND RELATED REQUIREMENTS.''

(4) Tell us when the test program is finished.

(5) Tell us the final disposition of the engines/equipment.

■ 245. Section 1068.215 is amended by revising the section heading and paragraphs (a) and (c)(3)(iv) to read as follows:

§ 1068.215 Exempting manufacturer-owned engines/equipment.

(a) You are eligible for this exemption for manufacturer-owned engines/equipment only if you are a certificate holder. Any engine for which you meet all applicable requirements under this section is exempt without request.

* * * * *

(c) * * *

(3) * * *

(iv) The statement: ''THIS [engine, equipment, vehicle, etc.] IS EXEMPT UNDER 40 CFR 1068.210 OR 1068.215 FROM EMISSION STANDARDS AND RELATED REQUIREMENTS.''

■ 246. Section 1068.220 is revised to read as follows:

§ 1068.220 Exempting display engines/equipment.

(a) Anyone may request an exemption for display engines/equipment.

(b) Nonconforming display engines/equipment will be exempted if they are used only for displays in the interest of a business or the general public. This exemption does not apply to engines/equipment displayed for private use, private collections, or any other purpose we determine is inappropriate for a display exemption.

(c) You may operate the exempted engine/equipment, but only if we approve specific operation that is part of the display, or is necessary for the display (possibly including operation that is indirectly necessary for the display). We may consider any relevant factor in our approval process, including the extent of the operation, the overall emission impact, and whether the engine/equipment meets emission requirements of another country.

(d) You may sell or lease the exempted engine/equipment only with our advance approval.

(e) To use this exemption, you must add a permanent label to all engines/equipment exempted under this section, consistent with § 1068.45, with at least the following items:

(1) The label heading ''EMISSION CONTROL INFORMATION''.

(2) Your corporate name and trademark.

(3) Engine displacement, family identification, and model year of the engine/equipment (as applicable), or whom to contact for further information.

(4) The statement: ''THIS [engine, equipment, vehicle, etc.] IS EXEMPT UNDER 40 CFR 1068.220 FROM EMISSION STANDARDS AND RELATED REQUIREMENTS.''

(f) We may set other conditions for approval of this exemption.

■ 247. Section 1068.225 is amended by revising the section heading and paragraph (d)(4) to read as follows:

§ 1068.225 Exempting engines/equipment for national security.

* * * * *

(d) * * *

(4) The statement: ''THIS [engine, equipment, vehicle, etc.] HAS AN EXEMPTION FOR NATIONAL SECURITY UNDER 40 CFR 1068.225.''

■ 248. Section 1068.230 is amended by revising the section heading and paragraphs (b) and (c) to read as follows:

§ 1068.230 Exempting engines/equipment for export.

* * * * *

(b) Engines/equipment exported to a country not covered by paragraph (a) of this section are exempt from the prohibited acts in this part without a request. If you produce exempt engines/equipment for export and any of them are sold or offered for sale to an ultimate purchaser in the United States, the exemption is automatically void for those engines/equipment, except as specified in § 1068.201(i). You may operate engines/equipment in the United States only as needed to prepare and deliver them for export.

(c) Except as specified in paragraph (d) of this section, label exempted engines/equipment (including shipping containers if the label on the engine/equipment will be obscured by the container) with a label showing that they are not certified for sale or use in the United States. This label may be permanent or removable. See § 1068.45 for provisions related to the use of removable labels and applying labels to containers without labeling individual engines/equipment. The label must include your corporate name and trademark and the following statement: ''THIS [engine, equipment, vehicle, etc.] IS SOLELY FOR EXPORT AND IS THEREFORE EXEMPT UNDER 40 CFR 1068.230 FROM U.S. EMISSION STANDARDS AND RELATED REQUIREMENTS.''

* * * * *

■ 249. Section 1068.235 is revised to read as follows:

§ 1068.235 Exempting nonroad engines/equipment used solely for competition.

The following provisions apply for nonroad engines/equipment, but not for motor vehicles:

(a) New nonroad engines/equipment you produce that are used solely for competition are excluded from emission standards. We may exempt (rather than exclude) new nonroad engines/equipment you produce that you intend to be used solely for competition, where we determine that such engines/equipment are unlikely to be used contrary to your intent. See the standard-setting parts for specific provisions where applicable. Note that the definitions in the standard-setting part may deem uncertified engines/equipment to be new upon importation.

(b) If you modify any nonroad engines/equipment after they have been placed into service in the United States so they will be used solely for competition, they are exempt without request. This exemption applies only to the prohibitions in § 1068.101(b)(1) and (2) and are valid only as long as the engine/equipment is used solely for competition. You may not use the provisions of this paragraph (b) to circumvent the requirements that apply to the sale of new competition engines under the standard-setting part.

(c) If you modify any nonroad engines/equipment under paragraph (b) of this section, you must destroy the original emission labels. If you loan, lease, sell, or give any of these engines/equipment to someone else, you must tell the new owner (or operator, if applicable) in writing that they may be used only for competition.

■ 250. Section 1068.240 is amended by revising the section heading and paragraphs (c)(1), (c)(3), and (e) introductory text to read as follows:

§ 1068.240 Exempting new replacement engines.

* * * * *

(c) * * *

(1) You may produce a limited number of replacement engines under this paragraph (c) representing 0.5 percent of your annual production volumes for each category and subcategory of engines identified in Table 1 to this section (1.0 percent through 2013). Calculate this number by multiplying your annual U.S.-directed production volume by 0.005 (or 0.01 through 2013) and rounding to the nearest whole number. Determine the appropriate production volume by identifying the highest total annual U.S.-directed production volume of engines from the previous three model years for all your certified engines from each category or subcategory identified in Table 1 to this section, as applicable. In unusual circumstances, you may ask us to base your production limits on U.S.-directed production volume for a model year more than three years prior. You may include stationary engines and exempted engines as part of your U.S.-directed production volume. Include U.S.-directed engines produced by any affiliated companies and those from any other companies you license to produce engines for you.

* * * * *

(3) Send the Designated Compliance Officer a report by September 30 of the year following any year in which you produced exempted replacement engines under this paragraph (c). In your report include the total number of replacement engines you produce under this paragraph (c) for each category or subcategory, as appropriate, and the corresponding total production volumes determined under paragraph (c)(1) of this section. If you send us a report under this paragraph (c)(3), you must also include the total number of replacement engines you produced under paragraphs (b), (d), and (e) of this section. Count exempt engines as tracked under paragraph (b) of this section only if you meet all the requirements and conditions that apply under paragraph (b) of this section by the due date for the annual report. You may include the information required under this paragraph (c)(3) in production reports required under the standard-setting part.

* * * * *

(e) *Partially complete current-tier replacement engines.* The provisions of paragraph (d) of this section apply for engines you produce from a current line of certified engines or vehicles if you ship them as partially complete engines for replacement purposes. This applies for engine-based and equipment-based standards as follows:

* * * * *

■ 251. Section 1068.245 is amended by revising the section heading and paragraph (g)(4) to read as follows:

§ 1068.245 Temporary provisions addressing hardship due to unusual circumstances.

* * * * *

(g) * * *

(4) A statement describing the engine's status as an exempted engine:

(i) If the engine/equipment does not meet any emission standards, add the following statement:"THIS [engine, equipment, vehicle, etc.] IS EXEMPT UNDER 40 CFR 1068.245 FROM EMISSION STANDARDS AND RELATED REQUIREMENTS."

(ii) If the engines/equipment meet alternate emission standards as a condition of an exemption under this section, we may specify a different statement to identify the alternate emission standards.

■ 252. Section 1068.250 is amended by revising the section heading and paragraphs (c) introductory text and (k)(4) and removing and reserving paragraph (h).

The revisions read as follows:

§ 1068.250 Extending compliance deadlines for small businesses under hardship.

* * * * *

(c) Send the Designated Compliance Officer a written request for an extension as soon as possible before you are in violation. In your request, show that all the following conditions and requirements apply:

* * * * *

(k) * * *

(4) A statement describing the engine's status as an exempted engine:

(i) If the engine/equipment does not meet any emission standards, add the following statement:"THIS [engine, equipment, vehicle, etc.] IS EXEMPT UNDER 40 CFR 1068.250 FROM EMISSION STANDARDS AND RELATED REQUIREMENTS."

(ii) If the engine/equipment meets alternate emission standards as a condition of an exemption under this section, we may specify a different statement to identify the alternate emission standards.

■ 253. Section 1068.255 is amended by revising the section heading and paragraph (a) introductory text to read as follows:

§ 1068.255 Exempting engines and fuel-system components for hardship for equipment manufacturers and secondary engine manufacturers.

* * * * *

(a) *Equipment exemption.* As an equipment manufacturer, you may ask for approval to produce exempted equipment for up to 12 months. We will generally limit this to a single interval up to 12 months in the first year that new or revised emission standards apply. Exemptions under this section are not limited to small businesses. Send the Designated Compliance Officer a written request for an exemption before you are in violation. In your request, you must show you are not at fault for the impending violation and that you would face serious economic hardship if we do not grant the exemption. This exemption is not available under this paragraph (a) if you manufacture the engine or fuel-system components you need for your own equipment, or if complying engines or fuel-system components are available from other manufacturers that could be used in your equipment, unless we allow it elsewhere in this chapter. We may impose other conditions, including provisions to use products meeting less stringent emission standards or to recover the lost environmental benefit. In determining whether to grant the exemptions, we will consider all relevant factors, including the following:

* * * * *

■ 254. Section 1068.260 is revised to read as follows:

§ 1068.260 General provisions for selling or shipping engines that are not yet in their certified configuration.

Except as specified in paragraph (e) of this section, all new engines in the United States are presumed to be subject to the prohibitions of § 1068.101, which generally require that all new engines be in a certified configuration before being sold, offered for sale, or introduced or delivered into commerce in the United States or imported into the United States. All emission-related components generally need to be installed on an engine for such an engine to be in its certified configuration. This section specifies clarifications and exemptions related to these requirements for engines. Except for paragraph (c) of this section, the provisions of this section generally apply for engine-based standards but not for equipment-based exhaust emission standards.

(a) The provisions of this paragraph (a) apply for emission-related components that cannot practically be assembled before shipment because they depend on equipment design parameters.

(1) You do not need an exemption to ship an engine that does not include installation or assembly of certain emission-related components, if those components are shipped along with the engine. For example, you may generally ship aftertreatment devices along with engines rather than installing them on the engine before shipment. We may require you to describe how you plan to use this provision.

(2) You may ask us at the time of certification for an exemption to allow you to ship your engines without emission-related components. If we allow this, we may specify conditions that we determine are needed to ensure that shipping the engine without such components will not result in the engine being operated outside of its certified configuration. You must identify unshipped parts by specific part numbers if they cannot be properly characterized by performance specification. For example, electronic control units, turbochargers, and EGR coolers must generally be identified by part number. Parts that we believe can be properly characterized by performance specification include air filters, noncatalyzed mufflers, and charge air coolers. See paragraph (d) of this section for additional provisions that apply in certain circumstances.

(b) You do not need an exemption to ship engines without specific components if they are not emission-related components identified in Appendix I of this part. For example, you may generally ship engines without the following parts:

(1) Radiators needed to cool the engine.

(2) Exhaust piping between the engine and an aftertreatment device, between two aftertreatment devices, or downstream of the last aftertreatment device.

(c) If you are a certificate holder, partially complete engines/equipment shipped between two of your facilities are exempt, subject to the provisions of this paragraph (c), as long as you maintain ownership and control of the engines/equipment until they reach their destination. We may also allow this where you do not maintain actual ownership and control of the engines/equipment (such as hiring a shipping company to transport the engines) but only if you demonstrate that the engines/equipment will be transported only according to your specifications. See § 1068.261(b) for the provisions that apply instead of this paragraph (c) for the special case of integrated manufacturers using the delegated-assembly exemption. Notify us of your intent to use this exemption in your application for certification, if applicable. Your exemption is effective when we grant your certificate. You may alternatively request an exemption in a separate submission; for example, this would be necessary if you will not be the certificate holder for the engines in question. We may require you to take specific steps to ensure that such engines/equipment are in a certified configuration before reaching the ultimate purchaser. Note that since this is a temporary exemption, it does not allow you to sell or otherwise distribute to ultimate purchasers an engine/equipment in an uncertified configuration with respect to exhaust emissions. Note also that the exempted engine/equipment remains new and subject to emission standards (see definition of ''exempted'' in § 1068.30) until its title is transferred to the ultimate purchaser or it otherwise ceases to be new.

(d) See § 1068.261 for delegated-assembly provisions in which certificate-holding manufacturers ship engines that are not yet equipped with certain emission-related components. See § 1068.262 for provisions related to manufacturers shipping partially complete engines for which a secondary engine manufacturer holds the certificate of conformity.

(e) Engines used in hobby vehicles are not presumed to be engines subject to the prohibitions of § 1068.101. Hobby vehicles are reduced-scale models of vehicles that are not capable of transporting a person. Some gas turbine engines are subject to the prohibitions of § 1068.101, but we do not presume that all gas turbine engines are subject to these prohibitions. Other engines that do not have a valid certificate of conformity or exemption when sold, offered for sale, or introduced or delivered into commerce in the United States or imported into the United States are presumed to be engines subject to the prohibitions of § 1068.101 unless we determine that such engines are excluded from the prohibitions of § 1068.101.

(f) While we presume that new non-hobby engines are subject to the prohibitions of § 1068.101, we may determine that a specific engine is not subject to these prohibitions based on information you provide or other information that is available to us. For example, the provisions of this part 1068 and the standard-setting parts provide for exemptions in certain circumstances. Also, some engines may be subject to separate prohibitions under subchapter C instead of the prohibitions of § 1068.101.

■ 255. Section 1068.261 is amended by revising the section heading and paragraph (a) to read as follows:

§ 1068.261 Delegated assembly and other provisions related to engines not yet in the certified configuration.

* * * * *

(a) Shipping an engine separately from an aftertreatment component that you have specified as part of its certified configuration will not be a violation of the prohibitions in § 1068.101(a)(1) subject to the provisions in this section. We may also require that you apply some or all of the provisions of this section for other components if we determine it is necessary to ensure that shipping the engine without such components will not result in the engine being operated outside of its certified configuration. In making this determination, we will consider the importance of the component for controlling emissions and the likelihood that equipment manufacturers will have an incentive to disregard your emission-related installation instructions based on any relevant factors, such as the cost of the component and any real or perceived expectation of a negative impact on engine or equipment performance.

* * * * *

■ 256. Section 1068.262 is revised to read as follows:

§ 1068.262 Shipment of engines to secondary engine manufacturers.

This section specifies how manufacturers may introduce into U.S. commerce partially complete engines that have an exemption or a certificate of conformity held by a secondary engine manufacturer and are not yet in a certified configuration. See the standard-setting part to determine whether and how the provisions of this section apply. (**Note:** See § 1068.261 for provisions related to manufacturers introducing into U.S. commerce partially complete engines for which they hold the certificate of conformity.) This exemption is temporary as described in paragraph (g) of this section.

(a) The provisions of this section generally apply where the secondary engine manufacturer has substantial control over the design and assembly of emission controls. In unusual circumstances we may allow other secondary engine manufacturers to use these provisions. In determining whether a manufacturer has substantial control over the design and assembly of emission controls, we would consider the degree to which the secondary engine manufacturer would be able to ensure that the engine will conform to the regulations in its final configuration. Such secondary engine manufacturers may finish assembly of partially complete engines in the following cases:

(1) You obtain an engine that is not fully assembled with the intent to manufacture a complete engine.

(2) You obtain an engine with the intent to modify it before it reaches the ultimate purchaser.

(3) You obtain an engine with the intent to install it in equipment that will be subject to equipment-based standards.

(b) Manufacturers may introduce into U.S. commerce partially complete engines as described in this section if they have a written request for such engines from a secondary engine manufacturer that has certified the engine and will finish the engine assembly. The written request must include a statement that the secondary engine manufacturer has a certificate of conformity for the engine and identify a valid engine family name associated with each engine model ordered (or the basis for an exemption if applicable, as specified in paragraph (e) of this section). The original engine manufacturer must apply a removable label meeting the requirements of § 1068.45 that identifies the corporate name of the original manufacturer and states that the engine is exempt under the provisions of § 1068.262. The name of the certifying manufacturer must also be on the label or, alternatively, on the bill of lading that accompanies the engines during shipment. The original engine manufacturer may not apply a permanent emission control information label identifying the engine's eventual status as a certified engine.

(c) If you are the secondary engine manufacturer and you will hold the certificate, you must include the following information in your application for certification:

(1) Identify the original engine manufacturer of the partially complete engine or of the complete engine you will modify.

(2) Describe briefly how and where final assembly will be completed. Specify how you have the ability to ensure that the engines will conform to the regulations in their final configuration. (**Note:** Paragraph (a) of this section prohibits using the provisions of this section unless you have substantial control over the design and assembly of emission controls.)

(3) State unconditionally that you will not distribute the engines without conforming to all applicable regulations.

(d) If you are a secondary engine manufacturer and you are already a certificate holder for other families, you may receive shipment of partially complete engines after you apply for a certificate of conformity but before the certificate's effective date. In this case, all the provisions of § 1068.103(c)(1) through (3) apply. This exemption allows the original manufacturer to ship engines after you have applied for a certificate of conformity. Manufacturers may introduce into U.S. commerce partially complete engines as described in this paragraph (d) if they have a written request for such engines from a secondary engine manufacturer stating that the application for certification has been submitted (instead of the information we specify in paragraph (b) of this section). We may set additional conditions under this paragraph (d) to prevent circumvention of regulatory requirements. Consistent with § 1068.103(c), we may also revoke an exemption under this paragraph (d) if we have reason to believe that the application for certification will not be approved or that the engines will otherwise not reach a certified configuration before reaching the ultimate purchaser. This may require that you export the engines.

(e) The provisions of this section also apply for shipping partially complete engines if the engine is covered by a valid exemption and there is no valid engine family name that could be used to represent the engine model. Unless we approve otherwise in advance, you may do this only when shipping engines to secondary engine manufacturers that are certificate holders. In this case, the secondary engine manufacturer must identify the regulatory cite identifying the applicable exemption instead of a valid engine family name when ordering engines from the original engine manufacturer.

(f) If secondary engine manufacturers determine after receiving an engine under this section that the engine will not be covered by a certificate or exemption as planned, they may ask us to allow for shipment of the engines back to the original engine manufacturer or to another secondary engine manufacturer. This might occur in the case of an incorrect shipment or excess inventory. We may modify the provisions of this section as appropriate to address these cases.

(g) Both original and secondary engine manufacturers must keep the records described in this section for at least five years, including the written request for engines and the bill of lading for each shipment (if applicable). The written request is deemed to be a submission to EPA and is thus subject to the reporting requirements of 40 CFR 1068.101(a)(2).

(h) These provisions are intended only to allow secondary engine manufacturers to obtain or transport engines in the specific circumstances identified in this section so any exemption under this section expires when the engine reaches the point of final assembly identified in paragraph (c)(2) of this section.

(i) For purposes of this section, an allowance to introduce partially complete engines into U.S. commerce includes a conditional allowance to sell, introduce, or deliver such engines into commerce in the United States or import them into the United States. It does not include a general allowance to offer such partially complete engines for sale because this exemption is intended to apply only for cases in which the certificate holder already has an arrangement to purchase the engines from the original engine manufacturer. This exemption does not allow the original engine manufacturer to subsequently offer the engines for sale to a different manufacturer who will hold the certificate unless that second manufacturer has also complied with the requirements of this part. The exemption does not apply for any individual engines that are not labeled as specified in this section or which are shipped to someone who is not a certificate holder.

(j) We may suspend, revoke, or void an exemption under this section, as follows:

(1) We may suspend or revoke your exemption if you fail to meet the requirements of this section. We may suspend or revoke an exemption related to a specific secondary engine manufacturer if that manufacturer sells engines that are in not in a certified configuration in violation of the regulations. We may disallow this exemption for future shipments to the affected secondary engine manufacturer or set additional conditions to ensure that engines will be assembled in the certified configuration.

(2) We may void an exemption for all the affected engines if you intentionally submit false or incomplete information or fail to keep and provide to EPA the records required by this section.

(3) The exemption is void for an engine that is shipped to a company that is not a certificate holder or for an engine that is shipped to a secondary engine manufacturer that is not in compliance with the requirements of this section.

(4) The secondary engine manufacturer may be liable for causing a prohibited act if voiding the exemption is due to its own actions.

(k) No exemption is needed to import equipment that does not include an engine. No exemption from exhaust emission standards is available under this section for equipment subject to equipment-based standards if the engine has been installed.

■ 257. Section 1068.265 is amended by revising the section heading to read as follows:

§ 1068.265 Provisions for engines/equipment conditionally exempted from certification.

* * * * *

Subpart D—Imports

■ 258. Section 1068.301 is amended by revising the section heading and paragraphs (b) and (d) and adding paragraph (e) to read as follows:

§ 1068.301 General provisions for importing engines/equipment.

* * * * *

(b) In general, engines/equipment that you import must be covered by a certificate of conformity unless they were built before emission standards started to apply. This subpart describes the limited cases where we allow importation of exempt or excluded engines/equipment. If an engine has an exemption from exhaust emission standards, this allows you to import the equipment under the same exemption.

* * * * *

(d) Complete the appropriate EPA declaration before importing any engines or equipment. These forms may be submitted and stored electronically and are available on the Internet at *http://www.epa.gov/OTAQ/imports/* or by phone at 734–214–4100. Importers must keep these records for five years and make them available promptly upon request.

(e) The standard-setting part may define uncertified engines/equipment to be ''new'' upon importation, whether or not they have already been placed into service. This may affect how the provisions of this subpart apply for your engines/equipment. (See the definition of ''new'' and other relevant terms in the standard-setting part.)

■ 259. Section 1068.305 is amended by revising paragraphs (b)(1) and (2) to read as follows:

§ 1068.305 How do I get an exemption or exclusion for imported engines/equipment?

* * * * *

(b) * * *

(1) Give your name, address, and telephone number.

(2) Give the engine/equipment owner's name, address, and telephone number.

* * * * *

■ 260. Section 1068.310 is amended by revising the section heading and paragraph (a) to read as follows:

§ 1068.310 Exclusions for imported engines/equipment.

* * * * *

(a) *Engines/equipment used solely for competition.* Engines/equipment that you demonstrate will be used solely for competition are excluded from the restrictions on imports in § 1068.301(b), but only if they are properly labeled. See the standard-setting part for provisions related to this demonstration that may apply. Section 1068.101(b)(4) prohibits anyone from using these excluded engines/equipment for purposes other than competition. We may waive the labeling requirement or allow a removable label for engines/equipment that are being temporarily imported for one or more specific competition events.

* * * * *

■ 261. Section 1068.315 is amended by revising the section heading and paragraph (i) to read as follows:

§ 1068.315 Permanent exemptions for imported engines/equipment.

* * * * *

(i) *Ancient engine/equipment exemption.* If you are not the original engine/equipment manufacturer, you may import nonconforming engines/equipment that are subject to a standard-setting part and were first manufactured at least 21 years earlier, as long as they are still substantially in their original configurations.

■ 262. Section 1068.325 is amended by revising the section heading, introductory text, and paragraphs (a), (c), (d), and (j)(5) to read as follows:

§ 1068.325 Temporary exemptions for imported engines/equipment.

You may import engines/equipment under certain temporary exemptions, subject to the conditions in this section. We may ask U.S. Customs and Border Protection to require a specific bond amount to make sure you comply with the requirements of this subpart. You may not sell or lease one of these engines/equipment while it is in the United States except as specified in this section or § 1068.201(i). You must eventually export the engine/equipment as we describe in this section unless it conforms to a certificate of conformity or it qualifies for one of the permanent exemptions in § 1068.315 or the standard-setting part.

(a) *Exemption for repairs or alterations.* You may temporarily import nonconforming engines/equipment under bond solely for repair or alteration, subject to our advance approval as described in paragraph (j) of this section. You may operate the engine/equipment in the United States only as necessary to repair it, alter it, or ship it to or from the service location. Export the engine/equipment directly after servicing is complete, or confirm that it has been destroyed.

* * * * *

(c) *Display exemption.* You may temporarily import nonconforming engines/equipment under bond for display if you follow the requirements of § 1068.220, subject to our advance approval as described in paragraph (j) of this section. This exemption expires one year after you import the engine/equipment, unless we approve your request for an extension. The engine/equipment must be exported (or destroyed) by the time the exemption expires or directly after the display concludes, whichever comes first.

(d) *Export exemption.* You may temporarily import nonconforming engines/equipment to export them, as described in § 1068.230. Label the engine/equipment as described in § 1068.230. You may sell or lease the engines/equipment for operation outside the United States consistent with the provisions of § 1068.230.

* * * * *

(j) * * *

(5) Acknowledge that EPA enforcement officers may conduct inspections or testing as allowed under the Clean Air Act.

* * * * *

■ 263. Section 1068.335 is amended by revising the section heading to read as follows:

§ 1068.335 Penalties for violations.

* * * * *

■ 264. Section 1068.360 is amended by revising the section heading and paragraph (b) to read as follows:

§ 1068.360 Restrictions for assigning a model year to imported engines and equipment.

* * * * *

(b) This paragraph (b) applies for the importation of engines and equipment that have not been placed into service, where the importation occurs in any calendar year that is more than one year after the named model year of the engine or equipment when emission control requirements applying to current engines are different than for engines or equipment in the named model year, unless they are imported under special provisions for Independent Commercial Importers as allowed under the standard-setting part. Regardless of what other provisions of this subchapter U specify for the model year of the engine or equipment, such engines and equipment are deemed to have an applicable model year no more than one year earlier than the calendar year in which they are imported. For example, a new engine identified as a 2007 model-year product that is imported on January 31, 2010 will be treated as a 2009 model-year engine; the same engine will be treated as a 2010 model-year engine if it is imported any time in calendar year 2011.

* * * * *

Subpart E—Selective Enforcement Auditing

■ 265. Section 1068.401 is revised to read as follows:

§ 1068.401 What is a selective enforcement audit?

(a) We may conduct or require you as a certificate holder to conduct emission tests on production engines/equipment in a selective enforcement audit. This requirement is independent of any requirement for you to routinely test production-line engines/equipment. Where there are multiple entities meeting the definition of manufacturer, we may require manufacturers other than the certificate holder to conduct or participate in the audit as necessary. For products subject to equipment-based standards, but tested using engine-based test procedures, this subpart applies to the engines and/or the equipment, as applicable. Otherwise this subpart applies to engines for products subject to engine-based standards and to equipment for products subject to equipment-based standards.

(b) If we send you a signed test order, you must follow its directions and the provisions of this subpart. We may tell you where to test the engines/equipment. This may be where you produce the engines/equipment or any other emission testing facility. You are responsible for all testing costs whether the testing is conducted at your facility or another facility.

(c) If we select one or more of your families for a selective enforcement audit, we will send the test order to the person who signed the application for certification or we will deliver it in person.

(d) If we do not select a testing facility, notify the Designated Compliance Officer within one working day of receiving the test order where you will test your engines/equipment.

(e) You must do everything we require in the audit without delay. We may suspend or revoke your certificate of conformity for the affected engine families if you do not fulfill your obligations under this subpart.

■ 266. Section 1068.405 is amended by revising paragraph (a)(1) to read as follows:

§ 1068.405 What is in a test order?

(a) * * *

(1) The family we have identified for testing. We may also specify individual configurations.

* * * * *

■ 267. Section 1068.415 is amended by revising paragraphs (c) and (d) to read as follows:

§ 1068.415 How do I test my engines/equipment?

* * * * *

(c) Test at least two engines/equipment in each 24-hour period (including void tests). However, for engines with maximum engine power above 560 kW, you may test one engine per 24-hour period. If you request and justify it, we may approve a lower testing rate.

(d) For exhaust emissions, accumulate service on test engines/equipment at a minimum rate of 6 hours per engine or piece of equipment during each 24-hour period; however, service accumulation to stabilize an engine's emission levels may not take longer than eight days. The first 24-hour period for service accumulation begins when you finish preparing an engine or piece of equipment for testing. The minimum service accumulation rate does not apply on weekends or holidays. We may approve a longer stabilization period or a lower service accumulation rate if you request and justify it. We may require you to accumulate hours more rapidly than the minimum rate, as appropriate. Plan your service accumulation to allow testing at the rate specified in paragraph (c) of this section. Select operation for accumulating operating hours on your test engines/equipment to represent normal in-use operation for the family.

* * * * *

■ 268. Section 1068.420 is amended by revising paragraphs (b) and (e) to read as follows:

§ 1068.420 How do I know when my engine family fails an SEA?

* * * * *

(b) Continue testing engines/equipment until you reach a pass decision for all pollutants or a fail decision for one pollutant, as described in paragraph (c) of this section.

* * * * *

(e) If you reach a pass decision for one pollutant, but need to continue testing for another pollutant, we will not use these later test results for the pollutant with the pass decision as part of the SEA.

* * * * *

■ 269. Section 1068.425 is amended by revising paragraph (b) to read as follows:

§ 1068.425 What happens if one of my production-line engines/equipment exceeds the emission standards?

* * * * *

(b) You may ask for a hearing relative to the suspended certificate of conformity for the failing engine/equipment as specified in subpart G of this part.

■ 270. Section 1068.430 is amended by revising paragraph (c) to read as follows:

§ 1068.430 What happens if a family fails an SEA?

* * * * *

(c) You may ask for a hearing as described in subpart G of this part up to 15 days after we suspend the certificate for a family. If we agree that we used erroneous information in deciding to suspend the certificate before a hearing is held, we will reinstate the certificate.

■ 271. Section 1068.450 is amended by revising paragraph (b) to read as follows:

§ 1068.450 What records must I send to EPA?

* * * * *

(b) We may ask you to add information to your written report, so we can determine whether your new engines/equipment conform to the requirements of this subpart.

* * * * *

Subpart F—Reporting Defects and Recalling Engines/Equipment

■ 272. Section 1068.501 is amended by revising paragraphs (a)(1)(iv), (a)(8), and (b)(1)(iii) to read as follows:

§ 1068.501 How do I report emission-related defects?

* * * * *

(a) * * *

(1) * * *

(iv) Any other component whose failure would commonly increase emissions of any regulated pollutant without significantly degrading engine/equipment performance.

* * * * *

(8) Send all reports required by this section to the Designated Compliance Officer.

* * * * *

(b) * * *

(1) * * *

(iii) You receive any other information for which good engineering judgment would indicate the component or system may be defective, such as information from dealers, field-service personnel, equipment manufacturers, hotline complaints, in-use testing, or engine diagnostic systems.

* * * * *

■ 273. Section 1068.505 is amended by revising paragraphs (a), (c), and (g) to read as follows:

§ 1068.505 How does the recall program work?

(a) If we make a determination that a substantial number of properly maintained and used engines/equipment do not conform to the regulations of this chapter during their useful life, you must submit a plan to remedy the nonconformity of your engines/equipment. We will notify you of our determination in writing. Our notice will identify the class or category of engines/equipment affected and describe how we reached our conclusion. If this happens, you must meet the requirements and follow the instructions in this subpart. You must remedy at your expense noncompliant engines/equipment that have been properly maintained and used, as described in § 1068.510(a)(7), regardless of their age or extent of service accumulation at the time of repair. You may not transfer this expense to a dealer (or equipment manufacturer for engine-based standards) through a franchise or other agreement.

* * * * *

(c) Unless we withdraw the determination of noncompliance, you must respond to it by sending a remedial plan to the Designated Compliance Officer. We will designate a date by which you must send us the remedial plan; the designated date will be no sooner than 45 days after we notify you, and no sooner than 30 days after a hearing.

* * * * *

(g) For purposes of recall, ''owner'' means someone who owns an engine or piece of equipment affected by a remedial plan.

■ 274. Section 1068.510 is amended by revising paragraph (a)(6) to read as follows:

§ 1068.510 How do I prepare and apply my remedial plan?

(a) * * *

(6) How you will notify owners; include a copy of any notification letters.

* * * * *

■ 275. Section 1068.515 is amended by revising paragraph (c) to read as follows:

§ 1068.515 How do I mark or label repaired engines/equipment?

* * * * *

(c) On the label, designate the specific recall campaign and identify the facility where you repaired or inspected the engine/equipment.

* * * * *

■ 276. Section 1068.530 is amended by revising the introductory text to read as follows:

§ 1068.530 What records must I keep?

We may review your records at any time so it is important that you keep required information readily available. Keep records associated with your recall campaign for five years after you send the last report we require under § 1068.525(b). Organize and maintain your records as described in this section.

* * * * *

■ 277. Subpart G is revised to read as follows:

Subpart G—Hearings

Sec.

Subpart G—Hearings

§ 1068.601 Overview.

The regulations of this chapter involve numerous provisions that may result in EPA making a decision or judgment that you may consider adverse to your interests and that either limits your business activities or requires you to pay penalties. As specified in the regulations, this might involve an opportunity for an informal hearing or a formal hearing that follows specific procedures and is directed by a Presiding Officer. The regulations generally specify when we would hold a hearing. In limited circumstances, we may grant a request for a hearing related to adverse decisions regarding regulatory provisions for which we do not specifically describe the possibility of asking for a hearing.

(a) If you request a hearing regarding our decision to assess administrative penalties under § 1068.125, we will hold a formal hearing according to the provisions of 40 CFR 22.1 through 22.32 and 22.34.

(b) For other issues where the regulation allows for a hearing in response to an adverse decision, you may request an informal hearing as described in § 1068.650. Sections 1068.610 through 1068.625 describe when and how to request an informal hearing under various circumstances.

(c) The time limits we specify are calendar days and include weekends and holidays, except that a deadline falling on a Saturday, Sunday, or a federal holiday is understood to move to the next business day. Your filing will be considered timely based on the following criteria relative to the specified deadline:

(1) The postmarked date for items sent by U.S. mail must be on or before the specified date.

(2) The ship date for items sent from any location within the United States by commercial carriers must be on or before the specified date.

(3) Items sent by mail or courier from outside the United States must be received by the specified date.

(4) The time and date stamp on an email message must be at or before 5:00 p.m. on the specified date.

(5) The time and date stamp on faxed pages must be at or before 5:00 p.m. on the specified date.

(6) Hand-delivered items must be received by the appropriate personnel by 3:00 p.m. on the specified date.

(d) See the standard-setting part for additional information. If the standard-setting part specifies any provisions that are contrary to those described in this subpart, the provisions of the standard-setting part apply instead of those described in this subpart.

§ 1068.610 Request for hearing—suspending, revoking, or voiding a certificate of conformity.

(a) You may request an informal hearing as described in § 1068.650 if you disagree with our decision to suspend, revoke, or void a certificate of conformity. We will approve your request for an informal hearing under this paragraph (a) if we find that your request raises a substantial factual issue in the decision we made that, if addressed differently, could alter the outcome of that decision.

(b) If you request a hearing regarding the outcome of a testing regimen with established evaluation criteria, such as selective enforcement audits or routine production-line testing, we will hold a hearing limited to the following issues that are relevant to your circumstances:

(1) Whether tests were conducted in accordance with applicable regulations.

(2) Whether test equipment was properly calibrated and functioning.

(3) Whether specified sampling procedures were followed to select engines/equipment for testing.

(4) Whether there is a basis for determining that the problems identified do not apply for engines/equipment produced at plants other than the one from which engines/equipment were selected for testing.

(c) You must send your hearing request in writing to the Designated Compliance Officer no later than 30 days after we notify you of our decision to suspend, revoke, or void your certificate, or by some later deadline we specify. If the deadline passes, we may nevertheless grant you a hearing at our discretion.

(d) Your hearing request must include the following information:

(1) Identify the classes or categories of engines/equipment that will be the subject of the hearing.

(2) State briefly which issues you will raise at the hearing for each affected class or category of engines/equipment.

(3) Specify why you believe the hearing will conclude in your favor for each of the issues you will raise.

(4) Summarize the evidence supporting your position on each of the issues you will raise and include any supporting data.

§ 1068.615 Request for hearing—denied application for certification, automatically suspended certificate, and determinations related to certification.

(a) You may request an informal hearing as described in § 1068.650 if we deny your application for a certificate of conformity, if your certificate of conformity is automatically suspended under the regulations, or if you disagree with determinations we make as part of the certification process. For example, you might disagree with our determinations regarding adjustable parameters under § 1068.50 or regarding your good engineering judgment under § 1068.5.

(b) You must send your hearing request in writing to the Designated Compliance Officer no later than 30 days after we notify you of our decision, or by some later deadline we specify. If the specified deadline passes, we may nevertheless grant you a hearing at our discretion.

(c) Your hearing request must include the information specified in § 1068.610(d).

(d) We will approve your request for an informal hearing if we find that your request raises a substantial factual issue in the decision we made that, if addressed differently, could alter the outcome of that decision.

§ 1068.620 Request for hearing—recall.

(a) You may request an informal hearing as described in § 1068.650 if you disagree with our decision to order a recall.

(b) You must send your hearing request in writing to the Designated Compliance Officer no later than 45 days after we notify you of our decision, or by some later deadline we specify. If the specified deadline passes, we may nevertheless grant you a hearing at our discretion.

(c) Your hearing request must include the information specified in § 1068.610(d).

§ 1068.625 Request for hearing—nonconformance penalties.

(a) You may request an informal hearing as described in § 1068.650 if you disagree with our determination of compliance level or penalty calculation or both. The hearing will address only whether the compliance level or penalty was determined in accordance with the regulations.

(b) Send a request for a hearing in writing to the Designated Compliance Officer within the following time frame, as applicable:

(1) No later than 15 days after we notify you that we have approved a nonconformance penalty under this subpart if the compliance level is in the allowable range of nonconformity.

(2) No later than 15 days after completion of the Production Compliance Audit if the compliance level exceeds the upper limit.

(3) No later than 15 days after we notify you of an adverse decision for all other cases.

(c) If you miss the specified deadline in paragraph (b) of this section, we may nevertheless grant you a hearing at our discretion.

(d) Your hearing request must include the information specified in § 1068.610(d).

(e) We will approve your request for an informal hearing if we find that your request raises a substantial factual issue in the decision we made that, if addressed differently, could alter the outcome of that decision.

§ 1068.650 Procedures for informal hearings.

(a) The following provisions apply for arranging the hearing:

(1) After granting your request for an informal hearing, we will designate a Presiding Officer for the hearing.

(2) The Presiding Officer will select the time and place for the hearing. The hearing must be held as soon as practicable for all parties involved.

(3) The Presiding Officer may require that all argument and presentation of evidence be concluded by a certain date after commencement of the hearing.

(b) The Presiding Officer will establish a paper or electronic hearing record, which may be made available for inspection. The hearing record includes, but is not limited to, the following materials:

(1) All documents relating to the application for certification, including the certificate of conformity itself, if applicable.

(2) Your request for a hearing and the accompanying supporting data.

(3) Correspondence and other data relevant to the hearing.

(4) The Presiding Officer's written decision regarding the subject of the hearing, together with any accompanying material.

(c) You may appear in person or you may be represented by counsel or by any other representative you designate.

(d) The Presiding Officer may arrange for a prehearing conference, either in response to a request from any party or at his or her own discretion. The Presiding Officer will select the time and place for the prehearing conference. The Presiding Officer will summarize the results of the conference and include the written summary as part of the record. The prehearing conference may involve consideration of the following items:

(1) Simplification of the issues.

(2) Stipulations, admissions of fact, and the introduction of documents.

(3) Limitation of the number of expert witnesses.

(4) Possibility of reaching an agreement to resolve any or all of the issues in dispute.

(5) Any other matters that may aid in expeditiously and successfully concluding the hearing.

(e) Hearings will be conducted as follows:

(1) The Presiding Officer will conduct informal hearings in an orderly and expeditious manner. The parties may offer oral or written evidence; however, the Presiding Officer may exclude evidence that is irrelevant, immaterial, or repetitious.

(2) Witnesses will not be required to testify under oath; however, the Presiding Officer must make clear that 18 U.S.C. 1001 specifies civil and criminal penalties for knowingly making false statements or representations or using false documents in any matter within the jurisdiction of EPA or any other department or agency of the United States.

(3) Any witness may be examined or cross-examined by the Presiding Officer, by you, or by any other parties.

(4) Written transcripts must be made for all hearings. Anyone may purchase copies of transcripts from the reporter.

(f) The Presiding Officer will make a final decision with written findings, conclusions and supporting rationale on all the substantial factual issues presented in the record. The findings, conclusions, and written decision must be provided to the parties and made a part of the record.

■ 278. Appendix I to part 1068 is amended by revising paragraph IV to read as follows:

APPENDIX I TO PART 1068—EMISSION–RELATED COMPONENTS

* * * * *

IV. Emission-related components also include any other part whose primary purpose is to reduce emissions or whose failure would commonly increase emissions without significantly degrading engine/equipment performance.

Department of Transportation

National Highway Traffic Safety Administration

49 CFR Chapter V

In consideration of the foregoing, under the authority of 49 U.S.C. 322, 5 U.S.C. 552, 49 U.S.C. 30166, 49 U.S.C. 30167, 49 U.S.C. 32307, 49 U.S.C. 32505, 49 U.S.C. 32708, 49 U.S.C. 32910, 49 U.S.C. 33116, 49 U.S.C. 32901, 49 U.S.C. 32902, 49 U.S.C. 30101, 49 U.S.C. 32905, 49 U.S.C. 32906, and delegation of authority at 49 CFR 1.95, NHTSA amends 49 CFR chapter V as follows:

PART 512—CONFIDENTIAL BUSINESS INFORMATION

■ 279. Revise the authority citation for part 512 to read as follows:

Authority: 49 U.S.C. 322; 5 U.S.C. 552; 49 U.S.C. 30166; 49 U.S.C. 30167; 49 U.S.C. 32307; 49 U.S.C. 32505; 49 U.S.C. 32708; 49 U.S.C. 32910; 49 U.S.C. 33116; delegation of authority at 49 CFR 1.95.

■ 280. Amend § 512.6 by revising paragraph (c)(2) to read as follows:

§ 512.6 How should I prepare documents when submitting a claim for confidentiality?

* * * * *

(c) * * *

(2) Confidential portions of electronic files submitted in other than their original format must be marked ''Confidential Business Information'' or ''Entire Page Confidential Business Information'' at the top of each page. If only a portion of a page is claimed to be confidential, that portion shall be designated by brackets. Files submitted in their original format that cannot be marked as described above must, to the extent practicable, identify confidential information by alternative markings using existing attributes within the file or means that are accessible through use of the file's associated program. When alternative markings are used, such as font changes or symbols, the submitter must use one method consistently for electronic files of the same type within the same submission. The method used for such markings must be described in the request for confidentiality. Files and materials that cannot be marked internally, such as video clips or executable files or files provided in a format specifically requested by the agency, shall be renamed prior to submission so the words ''Confidential Bus Info'' appears in the file name or, if that is not practicable, the characters ''Conf Bus Info'' or ''CBI'' appear. In all cases, a submitter shall provide an electronic copy of its request for confidential treatment on any medium containing confidential information, except where impracticable.

* * * * *

■ 281. Revise § 512.7 to read as follows:

§ 512.7 Where should I send the information for which I am requesting confidentiality?

Except for requests pertaining to information submitted under 49 CFR part 537, any claim for confidential treatment must be submitted to the Chief Counsel of the National Highway Traffic Safety Administration, 1200 New Jersey Avenue SE., West Building W41–227, Washington, DC 20590. Requests for confidential treatment for information submitted under 49 CFR part 537 shall accompany the submission and be provided to NHTSA through the electronic portal identified in 49 CFR 537.5(a)(4) or through an email address that will be provided and maintained by NHTSA.

PART 523—VEHICLE CLASSIFICATION

■ 282. Revise the authority citation for part 523 to read as follows:

Authority: 49 U.S.C. 32901; delegation of authority at 49 CFR 1.95.

■ 283. Revise § 523.2 to read as follows:

§ 523.2 Definitions.

Ambulance has the meaning given in 40 CFR 86.1803.

Approach angle means the smallest angle, in a plane side view of an automobile, formed by the level surface on which the automobile is standing and a line tangent to the front tire static loaded radius arc and touching the underside of the automobile forward of the front tire.

Axle clearance means the vertical distance from the level surface on which an automobile is standing to the lowest point on the axle differential of the automobile.

Base tire (for passenger automobiles, light trucks, and medium duty passenger vehicles) means the tire size specified as standard equipment by the manufacturer on each unique combination of a vehicle's footprint and model type. Standard equipment is defined in 40 CFR 86.1803.

Basic vehicle frontal area is used as defined in 40 CFR 86.1803 for passenger automobiles, light trucks, medium duty passenger vehicles and Class 2b through 3 pickup trucks and vans. For heavy-duty tracts and vocational vehicles, it has the meaning given in 40 CFR 1037.801.

Breakover angle means the supplement of the largest angle, in the plan side view of an automobile that can be formed by two lines tangent to the front and rear static loaded radii arcs and intersecting at a point on the underside of the automobile.

Cab-complete vehicle means a vehicle that is first sold as an incomplete vehicle that substantially includes the vehicle cab section as defined in 40 CFR 1037.801. For example, vehicles known commercially as chassis-cabs, cab-chassis, box-deletes, bed-deletes, and cut-away vans are considered cab-complete vehicles. A cab includes a steering column and a passenger compartment. Note that a vehicle lacking some components of the cab is a cab-complete vehicle if it substantially includes the cab.

Cargo-carrying volume means the luggage capacity or cargo volume index, as appropriate, and as those terms are defined in 40 CFR 600.315–08, in the case of automobiles to which either of these terms apply. With respect to automobiles to which neither of these terms apply, ''cargo-carrying volume'' means the total volume in cubic feet, rounded to the nearest 0.1 cubic feet, of either an automobile's enclosed nonseating space that is intended primarily for carrying cargo and is not accessible from the passenger compartment, or the space intended primarily for carrying cargo bounded in the front by a vertical plane that is perpendicular to the longitudinal centerline of the automobile and passes through the rearmost point on the rearmost seat and elsewhere by the automobile's interior surfaces.

Class 2b vehicles are vehicles with a gross vehicle weight rating (GVWR) ranging from 8,501 to 10,000 pounds.

Class 3 through Class 8 vehicles are vehicles with a gross vehicle weight rating (GVWR) of 10,001 pounds or more as defined in 49 CFR 565.15.

Commercial medium- and heavy-duty on-highway vehicle means an on-highway vehicle with a gross vehicle weight rating of 10,000 pounds or more as defined in 49 U.S.C. 32901(a)(7).

Complete vehicle has the meaning given to *completed vehicle* as defined in 49 CFR 567.3.

Curb weight has the meaning given in 49 CFR 571.3.

Dedicated vehicle has the same meaning as dedicated automobile as defined in 49 U.S.C. 32901(a)(8).

Departure angle means the smallest angle, in a plane side view of an automobile, formed by the level surface on which the automobile is standing and a line tangent to the rear tire static loaded radius arc and touching the underside of the automobile rearward of the rear tire.

Dual-fueled vehicle (multi-fuel, or flexible-fuel vehicle) has the same meaning as dual fueled automobile as defined in 49 U.S.C. 32901(a)(9).

Electric vehicle means a vehicle that does not include an engine, and is powered solely by an external source of electricity and/or solar power. Note that this does not include electric hybrid or fuel-cell vehicles that use a chemical fuel such as gasoline, diesel fuel, or hydrogen. Electric vehicles may also be referred to as all-electric vehicles to distinguish them from hybrid vehicles.

Emergency vehicle means one of the following:

(1) For passenger cars, light trucks and medium duty passenger vehicles, emergency vehicle has the meaning in 49 U.S.C. 32902(e).

(2) For heavy-duty vehicles, emergency vehicle has the meaning given in 40 CFR 1037.801.

Engine code has the meaning given in 40 CFR 86.1803.

Final stage manufacturer has the meaning given in 49 CFR 567.3.

Fire truck has the meaning given in 40 CFR 86.1803.

Footprint is defined as the product of track width (measured in inches, calculated as the average of front and rear track widths, and rounded to the nearest tenth of an inch) times wheelbase (measured in inches and rounded to the nearest tenth of an inch), divided by 144 and then rounded to the nearest tenth of a square foot. For purposes of this definition, track width is the lateral distance between the centerlines of the base tires at ground, including the camber angle. For purposes of this definition, wheelbase is the longitudinal distance between front and rear wheel centerlines.

Full-size pickup truck means a light truck or medium duty passenger vehicle that meets the requirements specified in 40 CFR 86.1866–12(e).

Gross axle weight rating (GAWR) has the meaning given in 49 CFR 571.3.

Gross combination weight rating (GCWR) has the meaning given in 49 CFR 571.3.

Gross vehicle weight rating (GVWR) has the meaning given in 49 CFR 571.3.

Heavy-duty engine means any engine used for (or for which the engine manufacturer could reasonably expect to be used for) motive power in a heavy-duty vehicle. For purposes of this definition in this part, the term ''engine'' includes internal combustion engines and other devices that convert chemical fuel into motive power. For example, a fuel cell and motor used in a heavy-duty vehicle is a heavy-duty engine.

Heavy-duty vehicle means a vehicle as defined in § 523.6.

Incomplete vehicle has the meaning given in 49 CFR 567.3.

Innovative technology means technology certified under 40 CFR 1036.610, 40 CFR 1037.610 and 49 CFR 535.7(f).

Light truck means a non-passenger automobile meeting the criteria in § 523.5.

Manufacturer has the meaning in 49 U.S.C. 30102.

Medium duty passenger vehicle means a vehicle which would satisfy the criteria in § 523.5 (relating to light trucks) but for its gross vehicle weight rating or its curb weight, which is rated at more than 8,500 lbs GVWR or has a vehicle curb weight of more than 6,000 pounds or has a basic vehicle frontal area in excess of 45 square feet, and which is designed primarily to transport passengers, but does not include a vehicle that—

(1) Is an ''incomplete vehicle''' as defined in this subpart; or

(2) Has a seating capacity of more than 12 persons; or

(3) Is designed for more than 9 persons in seating rearward of the driver's seat; or

(4) Is equipped with an open cargo area (for example, a pick-up truck box or bed) of 72.0 inches in interior length or more. A covered box not readily accessible from the passenger compartment will be considered an open cargo area for purposes of this definition.

Mild hybrid gasoline-electric vehicle means a vehicle as defined by EPA in 40 CFR 86.1866–12(e).

Motor home has the meaning given in 49 CFR 571.3.

Motor vehicle has the meaning giving in 49 U.S.C. 30102.

Off-cycle technology means technology certified under 40 CFR 1036.610, 40 CFR 1037.610 and 49 CFR 535.7(f).

Passenger-carrying volume means the sum of the front seat volume and, if any, rear seat volume, as defined in 40 CFR 600.315–08, in the case of automobiles to which that term applies. With respect to automobiles to which that term does not apply, ''passenger-carrying volume'' means the sum in cubic feet, rounded to the nearest 0.1 cubic feet, of the volume of a vehicle's front seat and seats to the rear of the front seat, as applicable, calculated as follows with the head room, shoulder room, and leg room dimensions determined in accordance with the procedures outlined in Society of Automotive Engineers Recommended Practice J1100, Motor Vehicle Dimensions (Report of Human Factors Engineering Committee, Society of Automotive Engineers, approved November 2009).

(1) For front seat volume, divide 1,728 into the product of the following SAE dimensions, measured in inches to the nearest 0.1 inches, and round the quotient to the nearest 0.001 cubic feet.

(i) H61-Effective head room—front.

(ii) W3-Shoulder room—front.

(iii) L34-Maximum effective leg room-accelerator.

(2) For the volume of seats to the rear of the front seat, divide 1,728 into the product of the following SAE dimensions, measured in inches to the nearest 0.1 inches, and rounded the quotient to the nearest 0.001 cubic feet.

(i) H63-Effective head room—second.

(ii) W4-Shoulder room—second.

(iii) L51-Minimum effective leg room—second.

Phase 1 means the greenhouse gas emissions standards and fuel efficiency standards for medium- and heavy-duty engines and vehicles program published in 2011, effective beginning with model year 2013.

Phase 2 means means the greenhouse gas emissions standards and fuel efficiency standards for medium- and heavy-duty engines and vehicles program effective beginning with model year 2018 for heavy-duty trailers and model year 2021 for all other heavy-duty vehicles and engines.

Pickup truck means a non-passenger automobile which has a passenger compartment and an open cargo area (bed).

Recreational vehicle or RV means a motor vehicle equipped with living space and amenities found in a motor home.

Running clearance means the distance from the surface on which an automobile is standing to the lowest point on the automobile, excluding unsprung weight.

Static loaded radius arc means a portion of a circle whose center is the center of a standard tire-rim combination of an automobile and whose radius is the distance from that center to the level surface on which the automobile is standing, measured with the automobile at curb weight, the wheel parallel to the vehicle's longitudinal centerline, and the tire inflated to the manufacturer's recommended pressure.

Strong hybrid gasoline-electric vehicle means a vehicle as defined by EPA in 40 CFR 86.1866–12(e).

Temporary living quarters means a space in the interior of an automobile in which people may temporarily live and which includes sleeping surfaces, such as beds, and household conveniences, such as a sink, stove, refrigerator, or toilet.

Transmission class has the meaning given in 40 CFR 600.002.

Tranmission configuration has the meaning given in 40 CFR 600.002.

Transmission type has the meaning given in 40 CFR 86.1803.

Van means a vehicle with a body that fully encloses the driver and a cargo carrying or work performing compartment. The distance from the leading edge of the windshield to the foremost body section of vans is typically shorter than that of pickup trucks and sport utility vehicles.

Vocational tractor means a tractor that is classified as a vocational vehicle according to 40 CFR 1037.630

Vocational vehicle means a vehicle that is equipped for a particular industry, trade or occupation such as construction, heavy hauling, mining, logging, oil fields, refuse and includes vehicles such as school buses, motorcoaches and RVs.

Work truck means a vehicle that is rated at more than 8,500 pounds and less than or equal to 10,000 pounds gross vehicle weight, and is not a medium-duty passenger vehicle as defined in 40 CFR 86.1803.

■ 284. Revise § 523.6 to read as follows:

§ 523.6 Heavy-duty vehicle.

(a) A heavy-duty vehicle is any commercial medium or heavy-duty on-highway vehicle or a work truck, as defined in 49 U.S.C. 32901(a)(7) and (19). For the purpose of this section, heavy-duty vehicles are divided into four regulatory categories as follows:

(1) Heavy-duty pickup trucks and vans;

(2) Heavy-duty vocational vehicles;

(3) Truck tractors with a GVWR above 26,000 pounds; and

(4) Heavy-duty trailers.

(b) The heavy-duty vehicle classification does not include vehicles excluded as specified in 49 CFR 535.3.

■ 285. Revise § 523.7 to read as follows:

§ 523.7 Heavy-duty pickup trucks and vans.

Heavy-duty pickup trucks and vans are pickup trucks and vans with a gross vehicle weight rating between 8,501 pounds and 14,000 pounds (Class 2b through 3 vehicles) manufactured as complete vehicles by a single or final stage manufacturer or manufactured as incomplete vehicles as designated by a manufacturer. A manufacturer may also optionally designate as a heavy-duty pickup truck or van any cab-complete or complete vehicle having a GVWR over 14,000 pounds and below 26,001 pounds equipped with a spark ignition engine or any spark ignition engine certified and sold as a loose engine manufactured for use in a heavy-duty pickup truck or van. See references in 40 CFR 86.1819, 40 CFR 1037.150, and 49 CFR 535.5(a).

■ 286. Add § 523.10 to read as follows:

§ 523.10 Heavy-duty trailers.

(a) A trailer means a motor vehicle with or without motive power, designed for carrying persons or property and for being drawn by another motor vehicle as defined in 49 CFR 571.3. For the purpose of this part, heavy-duty trailers include only those trailers designed to be drawn by a truck tractor or vocational tractor. Heavy-duty trailers may be divided into different types and categories as follows:

(1) Box vans are trailers with an enclosed cargo space that is permanently attached to the chassis, with fixed sides, nose, and roof and is designed to carry a wide range of freight. Tankers are not box vans.

(2) Box vans with self-contained refrigeration systems are refrigerated vans. All other box vans are dry vans.

(3) Trailers that are not box vans are non-box trailers. This includes chassis that are designed only for temporarily mounted containers.

(4) Box trailers with length greater than 50 feet are long box trailers. Other box trailers are short box trailers.

(b) Heavy-duty trailers does not include excluded trailers as specified in 49 CFR 535.3.

PART 534—RIGHTS AND RESPONSIBILITIES OF MANUFACTURERS IN THE CONTEXT OF CHANGES IN CORPORATE RELATIONSHIPS

■ 287. Revise the authority citation for part 534 to read as follows:

Authority: 49 U.S.C. 32901; delegation of authority at 49 CFR 1.95.

■ 288. Add § 534.8 to read as follows:

§ 534.8 Shared corporate relationships.

(a) Vehicles and engines built by multiple manufacturers can share responsibility for complying with fuel consumption standards in 49 CFR part 535, if allowed by EPA under 40 CFR 1037.620 and a joint agreement between the parties is sent to EPA and NHTSA.

(1) Each agreement must—

(i) Define how the vehicles and engines will be divided among each manufacturer;

(ii) Specify which manufacturer(s) will be responsible for the EPA certificates of conformity required in 40 CFR 1036.201 and 40 CFR 1037.201;

(iii) Describe the vehicles and engines in terms of the model types, production volumes, and model years (production periods if necessary);

(iv) Describe which manufacturer(s) have engineering and design control and sale distribution ownership over the vehicles and/or engines; and

(v) Include signatures from all parties involved in the shared corporate relationship.

(2) After defining the shared relationship between the manufacturers for the initiating model year, manufacturers cannot change the defined ownerships for subsequent model years unless one manufacturer assumes a successor relationship over another manufacturer that previously shared ownership.

(3) Multiple manufacturers must designate the same shared responsibility for complying with fuel consumption as selected for GHG standards unless otherwise allowed by EPA and NHTSA.

(b) NHTSA reserves the right to reject the joint agreement.

■ 289. Revise part 535 to read as follows:

PART 535 MEDIUM- AND HEAVY-DUTY VEHICLE FUEL EFFICIENCY PROGRAM

Sec.

Authority: 49 U.S.C. 32902 and 30101; delegation of authority at 49 CFR 1.95.

§ 535.1 Scope.

This part establishes fuel consumption standards pursuant to 49 U.S.C. 32902(k) for work trucks and commercial medium-duty and heavy-duty on-highway vehicles, including trailers (hereafter referenced as heavy-duty vehicles), and engines manufactured for sale in the United States and establishes a credit program manufacturers may use to comply with standards and requirements for manufacturers to provide reports to the National Highway Traffic Safety Administration regarding their efforts to reduce the fuel consumption of heavy-duty vehicles.

§ 535.2 Purpose.

The purpose of this part is to reduce the fuel consumption of new heavy-duty vehicles by establishing maximum levels for fuel consumption standards while providing a flexible credit program to assist manufacturers in complying with standards.

§ 535.3 Applicability.

(a) This part applies to manufacturers that produce complete and incomplete heavy-duty vehicles as defined in 49 CFR part 523, and to the manufacturers of all heavy-duty engines manufactured for use in the applicable vehicles for each given model year.

(b) Vehicle and engine manufacturers that must comply with this part include manufacturers required to have approved certificates of conformity from EPA as specified in 40 CFR parts 86, 1036, and 1037, except for minor differences in excluded vehicles as specified in paragraph (d) of this section.

(c) In certain special conditions where EPA allows manufacturers to designate other manufacturers to comply with GHG standards or grants special allowances in the construction of vehicles, as specified in 40 CFR 1037.620, 1037.621, and 1037.650, these allowances can be used to comply with the fuel consumption standards of this part.

(d) Manufacturers required to meet the fuel consumption standards of this part also include manufacturers completing, altering, or assembling motor vehicles or motor vehicle equipment into—

(1) Electric vehicles; and

(2) Alternative fueled vehicles from all types of heavy duty engine conversions.

(i) Entities that install alternative fuel conversion systems into vehicles acquired from vehicle manufacturers prior to first retail sale or introduction into interstate commerce may be regulated under this part if designated by the vehicle manufacturer and EPA to be the certificate holder.

(ii) Entities installing alternative fuel conversions are regulated as vehicle and engine manufacturers.

(iii) Entities can be omitted from compliance with vehicle based standards, if–

(A) Allowed by EPA;

(B) They provide a reasonable technical basis that the modified vehicle continues to meet vehicle standards; and

(C) They provide a joint agreement to EPA and NHTSA as specified in 49 CFR 534.7.

(e) The following heavy-duty vehicles and engines are excluded from the requirements of this part:

(1) Medium-duty passenger vehicles and other vehicles subject to the light-duty corporate average fuel economy standards in 49 CFR parts 531 and 533.

(2) Recreational vehicles, including motor homes manufactured before model year 2021 exept those produced by manufacturers voluntarily complying with NHTSA's early voational standards for model years 2013 through 2020.

(3) Heavy-duty trailers meeting one or more of the following criteria are excluded from vehicle standards in § 535.5(e):

(i) Trailers designed for in-field operations in logging or mining.

(ii) Trailers designed to operate at low speeds such that they are unsuitable for normal highway operation.

(iii) Trailers designed to perform their primary function while stationary, if they have permanently affixed components designed for heavy construction. This would include crane trailers and concrete trailers. Trailers would not qualify under this paragraph based on welding equipment or other components that are commonly used separate from trailers.

(iv) Trailers less than 35 feet long with three axles, and all trailers with four or more axles.

(v) Trailers intended for temporary or permanent residence, office space, or other work space, such as campers, mobile homes, and carnival trailers.

(vi) Trailers built before January 1, 2021, except those trailers voluntarily complaying with NHTSA's early trailer standards for model years 2018–2020.

(vii) Equipment that serves similar purposes to trailers but is not intended to be pulled by a tractor.

(viii) Containers that are not permanently mounted on chassis.

(ix) Trailers designed to be drawn by vehicles other than tractors, and those that are coupled to vehicles with pintle hooks or hitches instead of a fifth wheel.

(f) The following heavy-duty vehicles and engines are exempted from the requirements of this part:

(1) *Off-road vehicles.* Manufacturers producing heavy-duty vocational vehicles or vocational tractors that are intended for off-road use meeting the criteria of paragraph (f)(1)(i) of this section are exempted from vehicle standards in § 535.5(b) and (c) but must comply with engine standards in § 535.5(d).

(i) Vehicles primarily designed to perform work off-road (such as in oil fields, mining, forests, or construction sites), and meeting at least one of the criteria of paragraph (f)(1)(i)(A) of this section and at least one of the criteria of paragraph (f)(1)(i)(B) of this section.

(A) Vehicle must have affixed components designed to work in an off-road environment (for example, hazardous material equipment or drilling equipment) or was designed to operate at low speeds making them unsuitable for normal highway operation.

(B) Vehicles must—

(*1*) Have an axle that has a gross axle weight rating (GAWR) of 29,000 pounds or more;

(*2*) Have a speed attainable in 2 miles of not more than 33 mph; or

(*3*) Have a speed attainable in 2 miles of not more than 45 mph, an unloaded vehicle weight that is not less than 95 percent of its gross vehicle weight rating (GVWR), and no capacity to carry occupants other than the driver and operating crew.

(C) Manufacturers building tractors exempted under this provision must request preliminary approval before introducing vehicles into commerce. The request with supporting information must be sent to EPA that will coordinate with NHTSA in making a determination in accordance with 40 CFR 1037.210. Vehicles introduced into U.S. commerce without approval under this paragraph violate 40 CFR 1068.101(a)(1).

(ii) [Reserved]

(2) *Small business manufacturers.* (i) For Phase 1, small business manufacturers are exempted from the vehicle and engine standards of § 535.5, but must comply with the reporting requirements of § 535.8(g).

(ii) For Phase 2, fuel consumption standards apply on a delayed schedule for manufacturers meeting the small business criteria specified in 13 CFR 121.201 and in 40 CFR 86.1819–14(k)(5), 40 CFR 1036.150, and 40 CFR 1037.150. Qualifying manufacturers of truck tractors, vocational vehicles, heavy duty pickups and vans, and engines are not subject to the fuel consumption standards for vehicles and engines built before January 1, 2022. Qualifying manufacturers may choose to voluntarily comply early.

(iii) Small business manufacturers producing vehicles and engines that run on any fuel other than gasoline, E85, or diesel fuel meeting the criteria specified in 13 CFR 121.201 and in 40 CFR 86.1819–14(k)(5), 40 CFR 1036.150, and 40 CFR 1037.150 may delay complying with every new mandatory standard under this part by one model year.

(g) For model year 2021 and later, emergency vehicles may comply with alternative fuel consumption standards as specified in § 535.5(b)(5) instead of the standards specified in § 535.5(b)(4). Vehicles certified to these alternative standards may not generate or use positive fuel consumption credits but negative credits must be averaged within an averaging set.

(h) NHTSA may exclude or exempt vehicles and engines under special conditions allowed by EPA in accordance with 40 CFR parts 85, 86, 1036, 1037, and 1068. Manufacturers should consult the agencies if uncertain how to apply any EPA provision under the NHTSA fuel consumption program. Upon notification by EPA of a fraudulent use of an exemption, NHTSA reserves that right to suspend or revoke any exemption or exclusion.

§ 535.4 Definitions.

The terms manufacture and manufacturer are used as defined in section 501 of the Act and the terms commercial medium-duty and heavy-duty on highway vehicle, fuel and work truck are used as defined in 49 U.S.C. 32901.

Act means the Motor Vehicle Information and Cost Savings Act, as amended by Pub. L. 94–163 and 96–425.

Administrator means the Administrator of the National Highway Traffic Safety Administration (NHTSA) or the Administrator's delegate.

Advanced technology means vehicle technology under this fuel consumption program in §§ 535.6 and 535.7 and by EPA under 40 CFR 86.1819–14(d)(7), 1036.615, or 1037.615.

Alternative fuel conversion has the meaning given for clean alternative fuel conversion in 40 CFR 85.502.

A to B testing has the meaning given in 40 CFR 1037.801.

Automatic tire inflation system has the meaning in 40 CFR 1037.801.

Averaging set means, a set of engines or vehicles in which fuel consumption credits may be exchanged. Credits generated by one engine or vehicle family may only be used by other respective engine or vehicle families in the same averaging set. Note that an averaging set may comprise more than one regulatory subcategory. The averaging sets for this HD program are defined as follows:

(1) Heavy-duty pickup trucks and vans.

(2) Vocational light-heavy vehicles with a GVWR above 8,500 pounds but at or below 19,500 pounds.

(3) Vocational and tractor medium-heavy vehicles with a GVWR above 19,500 pounds but at or below 33,000 pounds.

(4) Vocational and tractor heavy-heavy vehicles with a GVWR above 33,000 pounds.

(5) Compression-ignition light heavy-duty engines for Class 2b to 5 vehicles with a GVWR above 8,500 pounds but at or below 19,500 pounds.

(6) Compression-ignition medium heavy-duty engines for Class 6 and 7 vehicles with a GVWR above 19,500 but at or below 33,000 pounds.

(7) Compression-ignition heavy heavy-duty engines for Class 8 vehicles with a GVWR above 33,000 pounds.

(8) Spark-ignition engines in Class 2b to 8 vehicles with a GVWR above 8,500 pounds.

(9) Long box van trailers.

(10) Short box van trailers.

(11) Long refrigerated box van trailers.

(12) Short refrigerated box van trailers.

Cab-complete vehicle has the meaning given in 49 CFR part 523.

Carryover means relating to certification based on emission data generated from an earlier model year.

Certificate holder means the manufacturer who holds the certificate of conformity for the vehicle or engine and that assigns the model year based on the date when its manufacturing operations are completed relative to its annual model year period.

Certificate of Conformity means an approval document granted by EPA to a manufacturer that submits an application for a vehicle or engine emissions family in 40 CFR 1036.205 and 1037.205. A certificate of conformity is valid from the indicated effective date until December 31 of the model year for which it is issued. The certificate must be renewed annually for any vehicle a manufacturer continues to produce.

Certification means process of obtaining a certificate of conformity for a vehicle family that complies with the emission standards and requirements in this part.

Certified emission level means the highest deteriorated emission level in an engine family for a given pollutant from the applicable transient and/or steady-state testing rounded to the same number of decimal places as the applicable standard. Note that you may have two certified emission levels for CO_2 if you certify a family for both vocational and tractor use.

Chassis-cab means the incomplete part of a vehicle that includes a frame, a completed occupant compartment and that requires only the addition of cargo-carrying, work-performing, or load-bearing components to perform its intended functions.

Chief Counsel means the NHTSA Chief Counsel, or his or her designee.

Complete sister vehicle is a complete vehicle of the same configuration as a cab-complete vehicle.

Complete vehicle has the meaning given in 49 CFR part 523.

Compression-ignition (CI) means relating to a type of reciprocating, internal-combustion engine, such as a diesel engine, that is not a spark-ignition engine. Note that 40 CFR 1036.1 also deems gas turbine engines and other engines to be compression-ignition engines.

Configuration means a subclassification within a test group for passenger cars, light trucks and medium-duty passenger vehicles and heavy-duty pickup trucks and vans which is based on basic engine, engine code, transmission type and gear ratios, and final drive ratio.

Curb weight has the meaning given in 40 CFR 86.1803.

Date of manufacture means the date on which the certifying vehicle manufacturer completes its manufacturing operations, except as follows:

(1) Where the certificate holder is an engine manufacturer that does not manufacture the complete or incomplete vehicle, the date of manufacture of the vehicle is based on the date assembly of the vehicle is completed.

(2) EPA and NHTSA may approve an alternate date of manufacture based on the date on which the certifying (or primary) vehicle manufacturer completes assembly at the place of main assembly, consistent with the provisions of 40 CFR 1037.601 and 49 CFR 567.4.

(3) A vehicle manufacturer that completes assembly of a vehicle at two or more facilities may ask to use as the month and year of manufacture, for that vehicle, the month and year in which manufacturing is completed at the place of main assembly, consistent with provisions of 49 CFR 567.4, as the model year. Note that such staged assembly is subject to the provisions of 40 CFR 1068.260(c). NHTSA's allowance of this provision is effective when EPA approves the manufacturer's certificates of conformity for these vehicles.

Day cab has the meaning given in 40 CFR 1037.801.

Emergency vehicle means a vehicle that meets one of the criteria in 40 CFR 1037.801.

Engine family has the meaning given in 40 CFR 1036.230.

Excluded means a vehicle or engine manufacturer or component is not required to comply with any aspects with the NHTSA fuel consumption program.

Exempted means a vehicle or engine manufacturer or component is not required to comply with certain provisions of the NHTSA fuel consumption program.

Family certification level (FCL) has the meaning given in 40 CFR 1036.801.

Family emission limit (FEL) has the meaning given in 40 CFR 1037.801.

Final drive ratio has the meaning in 40 CFR 1037.801.

Final-stage manufacturer has the meaning given in 49 CFR 567.3.

Fleet in this part means all the heavy-duty vehicles or engines within each of the regulatory sub-categories that are manufactured by a manufacturer in a particular model year and that are subject to fuel consumption standards under § 535.5.

Fleet average fuel consumption is the calculated average fuel consumption performance value for a manufacturer's fleet derived from the production weighted fuel consumption values of the unique vehicle configurations within each vehicle model type that makes up that manufacturer's vehicle fleet in a given model year. In this part, the fleet average fuel consumption value is determined for each manufacturer's fleet of heavy-duty pickup trucks and vans.

Fleet average fuel consumption standard is the actual average fuel consumption standard for a manufacturer's fleet derived from the production weighted fuel consumption standards of each unique vehicle configuration, based on payload, tow capacity and drive configuration (2, 4 or all-wheel drive), of the model types that makes up that manufacturer's vehicle fleet in a given model year. In this part, the fleet average fuel consumption standard is determined for each manufacturer's fleet of heavy-duty pickup trucks and vans.

Fuel cell means an electrochemical cell that produces electricity via the non-combustion reaction of a consumable fuel, typically hydrogen.

Fuel cell electric vehicle means a motor vehicle propelled solely by an electric motor where energy for the motor is supplied by a fuel cell.

Fuel efficiency means the amount of work performed for each gallon of fuel consumed.

Gaseous fuel has the meaning given in 40 CFR 1037.801.

Good engineering judgment has the meaning given in 40 CFR 1068.30. See 40 CFR 1068.5 for the administrative process used to evaluate good engineering judgment.

Heavy-duty off-road vehicle means a heavy-duty vocational vehicle or vocational tractor that is intended for off-road use.

Heavy-duty vehicle has the meaning given in 49 CFR part 523.

Heavy-haul tractor has the meaning given in 40 CFR 1037.801.

Heavy heavy-duty (HHD) vehicle means a Class 8 vehicle with a GVWR above 33,000 pounds.

Hybrid engine or hybrid powertrain means an engine or powertrain that includes energy storage features other than a conventional battery system or conventional flywheel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems. Note that certain provisions in this part treat hybrid engines and powertrains intended for vehicles that include regenerative braking different than those intended for vehicles that do not include regenerative braking.

Hybrid vehicle means a vehicle that includes energy storage features (other than a conventional battery system or conventional flywheel) in addition to an internal combustion engine or other engine using consumable chemical fuel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems Note that certain provisions in this part treat hybrid vehicles that include regenerative braking different than those that do not include regenerative braking.

Incomplete vehicle has the meaning given in 49 CFR part 523. For the purpose of this regulation, a manufacturer may request EPA and NHTSA to allow the certification of a vehicle as an incomplete vehicle if it manufactures the engine and sells the unassembled chassis components, provided it does not produce and sell the body components necessary to complete the vehicle.

Light heavy-duty (LHD) vehicle means a Class 2b through 5 vehicle with a GVWR at or below 19,500 pounds.

Liquefied petroleum gas (LPG) has the meaning given in 40 CFR 1036.801.

Low rolling resistance tire means a tire on a vocational vehicle with a tire rolling resistance level (TRRL) of 7.7 kg/metric ton or lower, a steer tire on a tractor with a TRRL of 7.7 kg/metric ton or lower, or a drive tire on a tractor with a TRRL of 8.1 kg/metric ton or lower.

Medium heavy-duty (MHD) vehicle means a Class 6 or 7 vehicle with a GVWR above 19,500 pounds GVWR but at or below 33,000 pounds.

Model type has the meaning given in 40 CFR 600.002.

Model year as it applies to engines means the manufacturer's annual new model production period, except as restricted under this definition. It must include January 1 of the calendar year for which the model year is named, may not begin before January 2 of the previous calendar year, and it must end by December 31 of the named calendar year. Manufacturers may not adjust model years to circumvent or delay compliance with standards.

Model year as it applies to vehicles means the manufacturer's annual new model production period, except as restricted under this definition and 40 CFR part 85, subpart X. It must include January 1 of the calendar year for which the model year is named, may not begin before January 2 of the previous calendar year, and it must end by December 31 of the named calendar year.

(1) The manufacturer who holds the certificate of conformity for the vehicle must assign the model year based on the date when its manufacturing operations are completed relative to its annual model year period.

(2) Unless a vehicle is being shipped to a secondary manufacturer that will hold the certificate of conformity, the model year must be assigned prior to introduction of the vehicle into U.S. commerce. The certifying manufacturer must redesignate the model year if it does not complete its manufacturing operations within the originally identified model year. A vehicle introduced into U.S. commerce without a model year is deemed to have a model year equal to the calendar year of its introduction into U.S. commerce unless the certifying manufacturer assigns a later date.

Natural gas has the meaning given in 40 CFR 1036.801. Vehicles that use a pilot-ignited natural gas engine (which uses a small diesel fuel ignition system), are still considered natural gas vehicles.

NHTSA Enforcement means the NHTSA Associate Administrator for Enforcement, or his or her designee.

Party means the person alleged to have committed a violation of § 535.9, and includes manufacturers of vehicles and manufacturers of engines.

Payload means in this part the resultant of subtracting the curb weight from the gross vehicle weight rating.

Petroleum has the meaning given in 40 CFR 1036.801.

Pickup truck has the meaning given in 49 CFR part 523.

Plug-in hybrid electric vehicle (PHEV) means a hybrid electric vehicle that has the capability to charge the battery or batteries used for vehicle propulsion from an off-vehicle electric source, such that the off-vehicle source cannot be connected to the vehicle while the vehicle is in motion.

Power take-off (PTO) means a secondary engine shaft or other system on a vehicle that provides substantial auxiliary power for purposes unrelated to vehicle propulsion or normal vehicle accessories such as air conditioning, power steering, and basic electrical accessories. A typical PTO uses a secondary shaft on the engine to transmit power to a hydraulic pump that powers auxiliary equipment such as a boom on a bucket truck.

Powertrain family has the meaning given in 40 CFR 1037.231. Manufacturers choosing to perform powertrain testing as specified in 40 CFR 1037.550, divide product lines into powertrain families that are expected to have similar fuel consumptions and CO_2 emission characteristics throughout the useful life.

Preliminary approval means approval granted by an authorized EPA representative prior to submission of an application for certification, consistent with the provisions of 40 CFR 1037.210. For requirements involing NHTSA, EPA will ensure decisions are jointly made and will convey the decision to the manufacturer.

Primary intended service class has the meaning for engines as specified in 40 CFR 1036.140.

Rechargeable Energy Storage System (RESS) means the component(s) of a hybrid engine or vehicle that store recovered energy for later use, such as the battery system in a electric hybrid vehicle.

Regulatory category means each of the four types of heavy-duty vehicles defined in 49 CFR 523.6 and the heavy-duty engines used in these heavy-duty vehicles.

Regulatory subcategory means the sub-groups in each regulatory category to which fuel consumption standards and requirements apply, and are defined as follows:

(1) Heavy-duty pick-up trucks and vans.

(2) Vocational vehicle subcategories are shown in Tables 1 and 2 below and include vocational tractors. Table 1 includes vehicles complying with Phase 1 standards. Phase 2 vehicles are included in Table 2 which have 21 separate subcategories to account for differences in engine type, GVWR, and the vehicle characteristics corresponding to the duty cycles for vocational vehicles.

TABLE 1—PHASE 1 VOCATIONAL VEHICLE SUBCATEGORIES

LHD vocational vehicles.
MHD vocational vehicles.
HHD vocational vehicles.

TABLE 2—PHASE 2 VOCATIONAL VEHICLE SUBCATEGORIES

Engine type	LHD vocational vehicles	MHD vocational vehicles	HHD vocational vehicles
CI	Urban	Urban	Urban.
CI	Multi-Purpose	Multi-Purpose	Multi-Purpose.
CI	Regional	Regional	Regional.
CI and SI	Emergency	Emergency	Emergency.
SI	Urban	Urban	Urban.
SI	Multi-Purpose	Multi-Purpose	Multi-Purpose.
SI	Regional	Regional	Regional.

(3) Tractor subcategories are shown in Table 3 below for Phase 1 and 2. Table 3 includes 10 separate subcategories for tractors complying with Phase 1 and 2 standards. The heavy-haul tractor subcategory only applies for Phase 2.

TABLE 3—PHASE 1 AND 2 TRUCK TRACTOR SUBCATEGORIES

Class 7	Class 8 day cabs	Class 8 sleeper cabs
Low-roof tractors	Low-roof day cab tractors	Low-roof sleeper cab tractors.
Mid-roof tractors	Mid-roof day cab tractors	Mid-roof sleeper cab tractors.
High-roof tractors	High-roof day cab tractors	High-roof sleeper cab tractors.
		Heavy-haul tractors (applies only to Phase 2 program).

(4) Trailer subcategories are shown in Table 4 of this section for the Phase 2 program. Trailers do not comply under the Phase 1 program. Table 4 includes 10 separate subcategories for trailers, which are only subject to Phase 2 only standards.

TABLE 4—TRAILER SUBCATEGORIES

Full-aero trailers	Partial-aero trailers	Other trailers
Long box dry vans	Long box dry vans	Non-aero box vans.
Short box dry vans	Short box dry vans	Non-box trailers.
Long box refrigerated vans	Long box refrigerated vans	
Short box refrigerated vans	Short box refrigerated vans	

(5) Engine subcategories are shown in Table 5 below. Table 5 includes 6 separate subcategories for engines which are the same for Phase 1 and 2 standards.

TABLE 5—ENGINE SUBCATEGORIES

LHD engines	MHD engines	HHD engines
CI engines for vocational vehicles	CI engines for vocational vehicles	CI engines for vocational vehicles.
	CI engines for truck tractors	CI engines for truck tractors.
All spark-ignition engines.		

Roof height means the maximum height of a vehicle (rounded to the nearest inch), excluding narrow accessories such as exhaust pipes and antennas, but including any wide accessories such as roof fairings. Measure roof height of the vehicle configured to have its maximum height that will occur during actual use, with properly inflated tires and no driver, passengers, or cargo onboard. Determine the base roof height on fully inflated tires having a static loaded radius equal to the arithmetic mean of the largest and smallest static loaded radius of tires a manufacturer offers or a standard tire EPA approves. If a vehicle is equipped with an adjustable roof fairing, measure the roof height with the fairing in its lowest setting. Once the maximum height is determined, roof heights are divided into the following categories:

(1) Low-roof means a vehicle with a roof height of 120 inches or less.

(2) Mid-roof means a vehicle with a roof height between 121 and 147 inches.

(3) High-roof means a vehicle with a roof height of 148 inches or more.

Service class group means a group of engine and vehicle averaging sets defined as follows:

(1) Spark-ignition engines, light heavy-duty compression-ignition engines, light heavy-duty vocational vehicles and heavy-duty pickup trucks and vans.

(2) Medium heavy-duty compression-ignition engines and medium heavy-duty vocational vehicles and tractors.

(3) Heavy heavy-duty compression-ignition engines and heavy heavy-duty vocational vehicles and tractors.

Sleeper cab means a type of truck cab that has a compartment behind the driver's seat intended to be used by the driver for sleeping. This includes both cabs accessible from the driver's compartment and those accessible from outside the vehicle.

Small business manufacturer means a manufacturer meeting the criteria specified in 13 CFR 121.201. For manufacturers owned by a parent company, the employee and revenue limits apply to the total number employees and total revenue of the parent company and all its subsidiaries.

Spark-ignition (SI) means relating to a gasoline-fueled engine or any other type of engine with a spark plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle. Spark-ignition engines usually use a throttle to regulate intake air flow to control power during normal operation. Note that some spark-ignition engines are subject to requirements that apply for compression-ignition engines as described in 40 CFR 1036.140.

Subconfiguration means a unique combination within a vehicle configuration of equivalent test weight, road-load horsepower, and any other operational characteristics or parameters that EPA determines may significantly affect CO_2 emissions within a vehicle configuration as defined in 40 CFR 600.002.

Standard payload means the payload assumed for each vehicle, in tons, for modeling and calculating emission credits, as follows:

(1) For vocational vehicles:

(i) 2.85 tons for light heavy-duty vehicles.

(ii) 5.6 tons for medium heavy-duty vehicles.

(iii) 7.5 tons for heavy heavy-duty vocational vehicles.

(2) For tractors:

(i) 12.5 tons for Class 7.

(ii) 19 tons for Class 8.

(iii) 43 tons for heavy-haul tractors.

(3) For trailers:

(i) 10 tons for short box vans.

(ii) 19 tons for other trailers.

Standard tractor has the meaning given in 40 CFR 1037.501.

Standard trailer has the meaning given in 40 CFR 1037.501.

Test group means the multiple vehicle lines and model types that share critical emissions and fuel consumption related features and that are certified as a group by a common certificate of conformity issued by EPA and is used collectively with other test groups within an averaging set or regulatory subcategory and is used by NHTSA for determining the fleet average fuel consumption.

Tire rolling resistance level (TRRL) means a value with units of kg/metric ton that represents that rolling resistance of a tire configuration. TRRLs are used as inputs to the GEM model under 40 CFR 1037.520. Note that a manufacturer may assign a value higher than a measured rolling resistance of a tire configuration.

Towing capacity in this part is equal to the resultant of subtracting the gross vehicle weight rating from the gross combined weight rating.

Trade means to exchange fuel consumption credits, either as a buyer or a seller.

Truck tractor has the meaning given in 49 CFR 571.3. This includes most heavy-duty vehicles specifically designed for the primary purpose of pulling trailers, but does not include vehicles designed to carry other loads. For purposes of this definition ''other loads'' would not include loads carried in the cab, sleeper compartment, or toolboxes. Examples of vehicles that are similar to tractors but that are not tractors under this part include dromedary tractors, automobile haulers, straight trucks with trailers hitches, and tow trucks.

U.S.-directed production volume means the number of vehicle units, subject to the requirements of this part, produced by a manufacturer for which the manufacturer has a reasonable assurance that sale was or will be made to ultimate purchasers in the United States.

Useful life has the meaning given in 40 CFR 1036.801 and 1037.801.

Vehicle configuration means a unique combination of vehicle hardware and calibration (related to measured or modeled emissions) within a vehicle family. Vehicles with hardware or software differences, but that have no hardware or software differences related to measured or modeled emissions or fuel consumption can be included in the same vehicle configuration. Note that vehicles with hardware or software differences related to measured or modeled emissions or fuel consumption are considered to be different configurations even if they have the same GEM inputs and FEL. Vehicles within a vehicle configuration differ only with respect to normal production variability or factors unrelated to measured or modeled emissions and fuel consumption for EPA and NHTSA.

Vehicle family has the meaning given in 40 CFR 1037.230. Manufacturers designate families in accordance with EPA provisions and may not choose different families between the NHTSA and EPA programs.

Vehicle service class has the meaning for vehicles as specified in the 40 CFR 1037.801.

Vocational tractor has the meaning given in 40 CFR 1037.801.

Zero emissions vehicle means an electric vehicle or a fuel cell vehicle.

§ 535.5 Standards.

(a) *Heavy-duty pickup trucks and vans.* Each manufacturer's fleet of heavy-duty pickup trucks and vans shall comply with the fuel consumption standards in this paragraph (a) expressed in gallons per 100 miles. Each vehicle must be manufactured to comply for its useful life. If the manufacturer's fleet includes conventional vehicles (gasoline, diesel and alternative fueled vehicles) and advanced technology vehicles in Phase 1 (hybrids with regenerative braking, vehicles equipped with Rankine-cycle engines, electric and fuel cell vehicles), it should divide its fleet into two separate fleets each with its own separate fleet average fuel consumption standard which the manufacturer must comply with the requirements of this paragraph (a). NHTSA standards correspond to the same requirements for EPA as specified in 40 CFR 86.1819–14.

(1) *Mandatory standards.* For model years 2016 and later, each manufacturer must comply with the fleet average standard derived from the unique subconfiguration target standards (or groups of subconfigurations approved by EPA in accordance with 40 CFR 86.1819) of the model types that make up the manufacturer's fleet in a given model year. Each subconfiguration has a unique attribute-based target standard, defined by each group of vehicles having the same payload, towing capacity and whether the vehicles are equipped with a 2-wheel or 4-wheel drive configuration. Phase 1 target standards apply for model years 2016 through 2020. Phase 2 target standards apply for model year 2021 and afterwards.

(2) *Subconfiguration target standards.* (i) Two alternatives exist for determining the subconfiguration target standards for Phase 1. For each alternative, separate standards exist for compression-ignition and spark-ignition vehicles:

(A) The first alternative allows manufacturers to determine a fixed fuel consumption standard that is constant over the model years; and

(B) The second alternative allows manufacturers to determine standards that are phased-in gradually each year.

(ii) Calculate the subconfiguration target standards as specified in this paragraph (a)(2)(ii), using the appropriate coefficients from Table 6 choosing between the alternatives in paragraph (a)(2)(i) of this section. For electric or fuel cell heavy-duty vehicles, use compression-ignition vehicle coefficients ''c'' and ''d'' and for hybrid (including plug-in hybrid), dedicated and dual-fueled vehicles, use coefficients ''c'' and ''d'' appropriate for the engine type used. Round each standard to the nearest 0.001 gallons per 100 miles and specify all weights in pounds rounded to the nearest pound. Calculate the subconfiguration target standards using the following equation:

Subconfiguration Target Standard (gallons per 100 miles) = $[c \times (WF)] + d$

Where:

WF = Work Factor = $[0.75 \times (\text{Payload Capacity} + \text{Xwd})] + [0.25 \times \text{Towing Capacity}]$

Xwd = 4wd Adjustment = 500 lbs if the vehicle group is equipped with 4wd and all-wheel drive, otherwise equals 0 lbs for 2wd.

Payload Capacity = GVWR (lbs) − Curb Weight (lbs) (for each vehicle group)

Towing Capacity = GCWR (lbs) − GVWR (lbs) (for each vehicle group)

TABLE 6—COEFFICIENTS FOR MANDATORY SUBCONFIGURATION TARGET STANDARDS

Model year(s)	c	d
Phase 1 Alternative 1—Fixed Target Standards		
CI Vehicle Coefficients		
2016 to 2018	0.0004322	3.330
2019 to 2020	0.0004086	3.143
SI Vehicle Coefficients		
2016 to 2018	0.0005131	3.961
2019 to 2020	0.0004951	3.815

TABLE 6—COEFFICIENTS FOR MANDATORY SUBCONFIGURATION TARGET STANDARDS—Continued

Model year(s)	c	d
Phase 1 Alternative 2—Phased-in Target Standards		
CI Vehicle Coefficients		
2016	0.0004519	3.477
2017	0.0004371	3.369
2018 to 2020	0.0004086	3.143
SI Vehicle Coefficients		
2016	0.0005277	4.073
2017	0.0005176	3.983
2018 to 2020	0.0004951	3.815
Phase 2—Fixed Target Standards		
CI Vehicle Coefficients		
2021	0.0003988	3.065
2022	0.0003880	2.986
2023	0.0003792	2.917
2024	0.0003694	2.839
2025	0.0003605	2.770
2026	0.0003507	2.701
2027 and later	0.0003418	2.633
SI Vehicle Coefficients		
2021	0.0004827	3.725
2022	0.0004703	3.623
2023	0.0004591	3.533
2024	0.0004478	3.443
2025	0.0004366	3.364
2026	0.0004253	3.274
2027 and later	0.0004152	3.196

(3) *Fleet average fuel consumption standard.* (i) Calculate each manufacturer's fleet average fuel consumption standard for conventional and advanced technology fleets separately based on the subconfiguration target standards specified in paragraph (a)(2) of this section, weighted to production volumes and averaged using the following equation combining all the applicable vehicles in a manufacturer's U.S.-directed fleet (compression-ignition, spark-ignition and advanced technology vehicles) for a given model year, rounded to the nearest 0.001 gallons per 100 miles:

$$\text{Fleet Average Standard} = \frac{\sum\left[\text{Subconfiguration Target Standard}_i \times \text{Volume}_i\right]}{\sum\left[\text{Volume}_i\right]}$$

Subconfiguration Target Standard_i = fuel consumption standard for each group of vehicles with same payload, towing capacity and drive configuration (gallons per 100 miles).

Volume_i = production volume of each unique subconfiguration of a model type based upon payload, towing capacity and drive configuration.

(A) A manufacturer may group together subconfigurations that have the same test weight (ETW), GVWR, and GCWR. Calculate work factor and target value assuming a curb weight equal to two times ETW minus GVWR.

(B) A manufacturer may group together other subconfigurations if it uses the lowest target value calculated for any of the subconfigurations.

(ii) For Phase 1, manufacturers must select an alternative for subconfiguration target standards at the same time they submit the model year 2016 pre-model year Report, specified in § 535.8. Once selected, the decision cannot be reversed and the manufacturer must continue to comply with the same alternative for subsequent model years.

(4) *Voluntary standards.* (i) Manufacturers may choose voluntarily to comply early with fuel consumption standards for model years 2013 through 2015, as determined in paragraphs (a)(4)(iii) and (iv) of this section, for example, in order to begin accumulating credits through over-compliance with the applicable standard. A manufacturer choosing early compliance must comply with all the vehicles and engines it manufactures in each regulatory category for a given model year.

(ii) A manufacturer must declare its intent to voluntarily comply with fuel consumption standards at the same time it submits a Pre-Model Report, prior to the compliance model year beginning as specified in § 535.8; and, once selected, the decision cannot be reversed and the manufacturer must continue to comply for each subsequent model year for all the vehicles and engines it manufactures in each regulatory category for a given model year.

(iii) Calculate separate subconfiguration target standards for compression-ignition and spark-ignition vehicles for model years 2013 through 2015 using the equation in paragraph (a)(2)(ii) of this section, substituting the appropriate values for the coefficients in the following table as appropriate:

TABLE 7—COEFFICIENTS FOR VOLUNTARY SUBCONFIGURATION TARGET STANDARDS

Model year(s)	c	d
CI Vehicle Coefficients		
2013 and 14	0.0004695	3.615
2015	0.0004656	3.595
SI Vehicle Coefficients		
2013 and 14	0.0005424	4.175
2015	0.0005390	4.152

(iv) Calculate the fleet average fuel consumption standards for model years 2013 through 2015 using the equation in paragraph (a)(3) of this section.

(5) *Exclusion of vehicles not certified as complete vehicles.* The vehicle standards in paragraph (a) of this section do not apply for vehicles that are chassis-certified with respect to EPA's criteria pollutant test procedure in 40 CFR part 86, subpart S. Any chassis-certified vehicles must comply with the vehicle standards and requirements of paragraph (b) of this section and the engine standards of paragraph (d) of this section for engines used in these vehicles. A vehicle manufacturer choosing to comply with this paragraph and that is not the engine manufacturer is required to notify the engine manufacturers that their engines are subject to paragraph (d) of this section and that it intends to use their engines in excluded vehicles.

(6) *Optional certification under this section.* Manufacturers may certify any complete or cab-complete Class 2b through 5 vehicles weighing at or below 19,500 pounds GVWR and any incomplete vehicles approved by EPA for inclusion under this paragraph to the same testing and standard that applies to a comparable complete sister vehicles as determined in accordance in 40 CFR 86.1819–14(j). Calculate the target standard value under paragraph (a)(2) of this section based on the same work factor value that applies for the complete sister vehicle.

(7) *Loose engines.* This paragraph applies for model year 2020 and earlier spark-ignition engines identical to engines used in vehicles certified to the standards of this paragraph (a), where manufacturers sell such engines as loose engines or installed in incomplete vehicles that are not cab-complete vehicles in accordance with 40 CFR 86.1819–14(k)(8). Vehicles in which those engines are installed are subject to standards in paragraph (b) of this section and the engines are subject to standards in paragraph (d) of this section. Loose engines produced each model year must comply with provisions of 40 CFR 86.1819–14(k)(8).

(8) *Alternative fuel vehicle conversions.* Alternative fuel vehicle conversions may demonstrate compliance with the standards of this part or other alternative compliance approaches allowed by EPA in 40 CFR 85.525.

(9) *Useful life.* The following useful life values apply for the standards of this section:

(i) 120,000 miles or 10 years, whichever comes first, for Class 2b through Class 3 heavy-duty pickup trucks and vans certified to Phase 1 standards.

(ii) 150,000 miles or 15 years, whichever comes first, for Class 2b through Class 3 heavy-duty pickup trucks and vans certified to Phase 2 standards.

(iii) For Phase 1 credits that you calculate based on a useful life of 120,000 miles, multiply any banked credits that you carry forward for use into the Phase 2 program by 1.25. For Phase 1 credit deficits that you generate based on a useful life of 120,000 miles multiply the credit deficit by 1.25 if offsetting the shortfall with Phase 2 credits.

(10) *Optional standards.* For model years 2013 through 2019, manufacturers may calculate target standards ''c'' coefficients rounded to the nearest six decimal places (0.000001) and ''d'' coefficients rounded to the nearest two decimal places (0.01) based on the standards listed in tables 6 or 7. If a manufacturer chooses this option, the fleet standard calculated in accordance with paragraph (a)(3) of this section and fuel consumption rate calculated in accordance with paragraph (a)(5) of this section must be rounded to the nearest 0.01 gallons per 100 miles. If a manufacturer chooses this provision it will be applicable for all model years 2013 through 2019.

(b) *Heavy-duty vocational vehicles.* Each manufacturer building a complete or incomplete heavy-duty vocational vehicles shall comply with the fuel consumption standards in this paragraph (b) expressed in gallons per 1000 ton-miles. Engines used in heavy-duty vocational vehicles shall comply with the standards in paragraph (d) of this section. Each vehicle must be manufactured to comply for its useful life.

(1) *Mandatory standards.* Heavy-duty vocational vehicles produced for Phase 1 must comply with the fuel consumption standards in paragraph (b)(3) of this section. For Phase 2, each vehicle manufacturer of heavy-duty vocational vehicles must comply with the fuel consumption standards in paragraph (b)(4) of this section.

(i) For model years 2016 to 2020, the heavy-duty vocational vehicles are subdivided by GVWR into three regulatory subcategories as defined in § 535.4, each with its own assigned standard.

(ii) For model years 2021 and later, the heavy-duty vocational vehicle category is subdivided into 21 regulatory subcategories depending upon whether vehicles are equipped with a compression or spark ignition engine, as defined in § 535.4. Each subcategory has its own assigned standard.

(iii) For purposes of certifying vehicles to fuel consumption standards, manufacturers must divide their product lines in each regulatory subcategory into vehicle families that have similar emissions and fuel consumption features, as specified by EPA in 40 CFR part 1037, subpart C. These families will be subject to the applicable standards. Each vehicle family is limited to a single model year.

(2) *Voluntary compliance.* (i) For model years 2013 through 2015, a manufacturer may choose voluntarily to comply early with the fuel consumption standards provided in paragraph (b)(3) of this section. For example, a manufacturer may choose to comply early in order to begin accumulating credits through over-compliance with the applicable standards. A manufacturer choosing early compliance must comply with all the vehicles and engines it manufacturers in each regulatory category for a given model year.

(ii) A manufacturer must declare its intent to voluntarily comply with fuel consumption standards and identify its plans to comply before it submits its first application for a certificate of conformity for the respective model year as specified in § 535.8; and, once selected, the decision cannot be reversed and the manufacturer must continue to comply for each subsequent model year for all the vehicles and engines it manufacturers in each regulatory category for a given model year.

(3) *Regulatory subcategory standards for model years 2013 to 2020.* The mandatory and voluntary fuel consumption standards for heavy-duty vocational vehicles are given in the following table:

TABLE 8—PHASE 1 VOCATIONAL VEHICLE FUEL CONSUMPTION STANDARDS

[Gallons per 1000 ton-miles]

Regulatory subcategories	LHD Vocational vehicles	MHD Vocational vehicles	HHD Vocational vehicles
Model Years 2013 to 2016 Voluntary Standards			
Standard	38.1139	22.9862	22.2004
Model Years 2017 to 2020 Mandatory Standards			
Standard	36.6405	22.1022	21.8075

(4) *Regulatory subcategory standards for model years 2021 and later.* The mandatory fuel consumption standards for heavy-duty vocational vehicles are given in the following table:

TABLE 9—PHASE 2 VOCATIONAL VEHICLE FUEL CONSUMPTION STANDARDS

[gallons per 1000 ton-miles]

Duty cycle	LHD Vocational vehicles	MHD Vocational vehicles	HHD Vocational vehicles
Model Years 2021 to 2023 Standards for CI Vehicles			
Urban	29.0766	18.4676	19.4499
Multi-Purpose	29.9607	18.6640	19.6464
Regional	31.2377	18.2711	18.5658
Model Years 2021 to 2023 Standards for SI Vehicles			
Urban	36.0077	22.8424	24.0801
Multi-Purpose	37.0204	23.0674	24.3052
Regional	38.5957	22.6173	22.9549
Model Years 2024 to 2026 Standards for CI Vehicles			
Urban	27.8978	17.5835	18.6640
Multi-Purpose	28.6837	17.7800	18.8605
Regional	29.8625	17.4853	17.8782
Model Years 2024 to 2026 Standards for SI Vehicles			
Urban	35.1075	22.1672	23.4050
Multi-Purpose	36.1202	22.3923	23.6300
Regional	37.5830	22.0547	22.3923
Model Years 2027 and later Standards for CI Vehicles			
Urban	26.7191	16.8959	17.8782
Multi-Purpose	27.5049	17.0923	17.9764
Regional	28.6837	16.6994	17.0923
Model Years 2027 and later Standards for SI Vehicles			
Urban	33.6446	21.2670	22.0547
Multi-Purpose	34.6574	21.4921	22.2797

TABLE 9—PHASE 2 VOCATIONAL VEHICLE FUEL CONSUMPTION STANDARDS—Continued

[gallons per 1000 ton-miles]

Duty cycle	LHD Vocational vehicles	MHD Vocational vehicles	HHD Vocational vehicles
Regional	36.1202	21.0420	21.1545

(5) *Regulatory subcategory standards for model year 2021 and later emergency vehicles.* The mandatory fuel consumption standards for heavy-duty emergency vehicles are given in the following table:

TABLE 10—PHASE 2 EMERGENCY VEHICLE FUEL CONSUMPTION STANDARDS

[Gallons per 1000 ton-miles] *

Regulatory subcategories	LHD Vocational vehicles	MHD Vocational vehicles	HHD Vocational vehicles
Model Years 2021 and later Emergency Vehicle Standards	30.6483	19.1552	21.1198

* Vehicles certified to these alternative standards may not generate fuel consumption credits.

(6) *Subfamily standards.* Manufacturers may specify a family emission limit (FEL) in terms of fuel consumption for each vehicle subfamily. The FEL may not be less than the result of fuel consumption modeling from 40 CFR 1037.520. The FELs is the fuel consumption standards for the vehicle subfamily instead of the standards specified in paragraph (b)(3) and (4) of this section and can be used for calculating fuel consumption credits in accordance with § 535.7.

(7) *Vehicle families for advanced and innovative technologies.* For vocational vehicles subject to Phase 1 standards, manufacturers must create separate vehicle families for vehicles that contain advanced or off-cycle technologies and group those vehicles together in a vehicle family if they use the same advanced or innovative technologies.

(8) *Certifying across service classes.* A manufacturer may optionally certify a vocational vehicle to the standards and useful life applicable to a heavier vehicle service class (or regulatory subcategory changes such as complying with the heavy heavy-duty standard instead of medium heavy-duty standard), provided the manufacturer does not generate credits with the vehicle. If a manufacturer includes lighter vehicles in a credit-generating subfamily (with an FEL below the standard), they must exclude their production volume from the credit calculation. Note that if the subfamily is a credit-using subfamily, the manufacturer must include the production volume of the lighter vehicles in the credit calculations.

(9) *Off-road exemptions.* Heavy-duty vocational vehicles, including vocational tractors meeting the off-road criteria in § 535.3 are exempted from the requirements in this paragraph (b) of this section, but the engines in these vehicles must meet the requirements of paragraph (d) of this section. Manufacturers may request approval in accordance with the provisions in 40 CFR 1037.150 and 40 CFR 1037.210 to determine if they are producing vehicles that meet the criteria for the heavy-duty off-road vehicle exemption. A manufacturer's request must be submitted in advance of the model year, or early enough in the model year, to ensure that an application for a certificate of conformity, as required in 40 CFR 1037.201, can be submitted if the approval is denied. The approval is a collaboration between NHTSA and EPA and can be given informally or through a formal determination. If a manufacturer requests a formal determination, the manufacturer must submit the required documentation in 40 CFR 1037.150 to both agenices.

(10) *Small business alternative fuel engine converters.* Small business alternative fuel engine converters may delay implementation of the standards in paragraph (b)(4) of this section for one year for each increase in stringency throughout the proposed rule.

(11) *Useful life.* The following useful life values apply for the standards of this section:

(i) 110,000 miles or 10 years, whichever comes first, for Class 2b through Class 5 vocational vehicles certified to Phase 1 standards.

(ii) 150,000 miles or 15 years, whichever comes first, for Class 2b through Class 5 vocational vehicles certified to Phase 2 standards.

(iii) 185,000 miles or 10 years, whichever comes first, for Class 6 and Class 7 vehicles above 19,500 pounds GVWR and at or below 33,000 pounds GVWR for Phase 1 and for Phase 2.

(iv) 435,000 miles or 10 years, whichever comes first, for Class 8 vehicles above 33,000 pounds GVWR for Phase 1 and for Phase 2.

(v) For Phase 1 credits that you calculate based on a useful life of 110,000 miles, multiply any banked credits that you carry forward for use into the Phase 2 program by 1.36. For Phase 1 credit deficits that you generate based on a useful life of 110,000 miles multiply the credit deficit by 1.36, if offsetting the shortfall with Phase 2 credits.

(12) *Recreational vehicles.* Recreational vehicles manufactured after model year 2020 must comply with the fuel consumption standards of this section. Manufacturers producing these vehicles may also certify to fuel consumption standards from 2014 through model year 2020. Manufacturers may earn credits retroactively for early compliance with fuel consumption standards. Once selected, a manufacturer cannot reverse the decision and the manufacturer must continue to comply for each subsequent model year for all the vehicles it manufacturers in each regulatory subcategory for a given model year.

(13) *Optional standards.* (i) For model years 2013 through 2019, manufacturers have the option to use heavy-duty vocational vehicle fuel consumption standards given in the following table:

TABLE 11—OPTIONAL VOCATIONAL VEHICLE FUEL CONSUMPTION STANDARDS

[Gallons per 1,000 ton-miles]

Regulatory subcategories	LH vehicles	MH vehicles	HH vehicles
Model Years 2017 to 2019 Mandatory Standards			
Standard	36.7	22.1	21.8
Model Year 2016 Mandatory Standard			
Standard	38.1	23.0	22.2
Model Years 2013 to 2015 Voluntary Standards			
Standard	38.1	23.0	22.2

(ii) If a manufacturer chooses this option, the fuel consumption rate calculated in accordance with 49 CFR 535.6(b)(4) must be rounded to the nearest 0.1 gallons per 1,000 ton-miles.

(iii) If a manufacturer chooses this option, it must apply these same standards for each model year from 2013 through 2019.

(c) *Truck tractors.* Each manufacturer building truck tractors, except vocational tractors, with a GVWR above 26,000 pounds shall comply with the fuel consumption standards in this paragraph (c) expressed in gallons per 1000 ton-miles. Each vehicle must be manufactured to comply for its useful life.

(1) *Mandatory standards.* For model years 2016 and later, each manufacturer of truck tractors must comply with the fuel consumption standards in paragraph (c)(3) of this section.

(i) Based on the roof height and the design of the cab, truck tractors are divided into subcatagories as described in § 535.4. The standards that apply to each regulatory subcategory are shown in paragraphs (c)(2) and (3) of this section, each with its own assigned standard.

(ii) For purposes of certifying vehicles to fuel consumption standards, manufacturers must divide their product lines in each regulatory subcategory into vehicles families that have similar emissions and fuel consumption features, as specified by EPA in 40 CFR 1037.230, and these families will be subject to the applicable standards. Each vehicle family is limited to a single model year.

(iii) Standards for truck tractor engines are given in paragraph (d) of this section.

(2) *Voluntary compliance.* (i) For model years 2013 through 2015, a manufacturer may choose voluntarily to comply early with the fuel consumption standards provided in paragraph (c)(3) of this section. For example, a manufacturer may choose to comply early in order to begin accumulating credits through over-compliance with the applicable standards. A manufacturer choosing early compliance must comply with all the vehicles and engines it manufacturers in each regulatory category for a given model year.

(ii) A manufacturer must declare its intent to voluntarily comply with fuel consumption standards and identify its plans to comply before it submits its first application for a certificate of conformity for the respective model year as specified in § 535.8; and, once selected, the decision cannot be reversed and the manufacturer must continue to comply for each subsequent model year for all the vehicles and engines it manufacturers in each regulatory category for a given model year.

(3) *Regulatory subcategory standards.* The fuel consumption standards for truck tractors, except for vocational tractors, are given in the following table:

TABLE 12—TRUCK TRACTOR FUEL CONSUMPTION STANDARDS

[Gallons per 1,000 ton-miles]

Regulatory subcategories	Day cab		Sleeper cab	Heavy-haul
	Class 7	Class 8	Class 8	
Phase 1—Model Years 2013 to 2015 Voluntary Standards				
Low Roof	10.5108	7.9568	6.6798	
Mid Roof	11.6896	8.6444	7.4656	
High Roof	12.1807	9.0373	7.3674	
Phase 1—Model Year 2016 Mandatory Standard				
Low Roof	10.5108	7.9568	6.6798	
Mid Roof	11.6896	8.6444	7.4656	
High Roof	12.1807	9.0373	7.3674	
Phase 1—Model Years 2017 to 2020 Mandatory Standards				
Low Roof	10.2161	7.8585	6.4833	
Mid Roof	11.2967	8.4479	7.1709	
High Roof	11.7878	8.7426	7.0727	

TABLE 12—TRUCK TRACTOR FUEL CONSUMPTION STANDARDS—Continued

[Gallons per 1,000 ton-miles]

Regulatory subcategories	Day cab		Sleeper cab	Heavy-haul
	Class 7	Class 8	Class 8	
Phase 2—Model Years 2021 to 2023 Mandatory Standards				
Low Roof	9.5285	7.6621	6.8762	5.3045
Mid Roof	10.5108	8.2515	7.6621	
High Roof	10.7073	8.4479	7.5639	
Phase 2—Model Years 2024 to 2026 Mandatory Standards				
Low Roof	8.8409	7.0727	6.2868	5.1081
Mid Roof	9.8232	7.6621	6.9745	
High Roof	9.9214	7.7603	6.8762	
Phase 2—Model Years 2027 and later Mandatory Standards				
Low Roof	8.5462	6.8762	6.0904	5.0098
Mid Roof	9.4303	7.4656	6.7780	
High Roof	9.4303	7.4656	6.5815	

(4) *Subfamily standards.* Manufacturers may specify a family emission limit (FEL) in terms of fuel consumption for each vehicle subfamily. The FEL may not be less than the result of fuel consumption modeling from 40 CFR 1037.520. The FEL serves as the fuel consumption standards for the vehicle subfamily instead of the standards specified in paragraph (c)(3) of this section and can be used for calculating fuel consumption credits in accordance with § 535.7.

(5) *Vehicle families for advanced and innovative technologies.* For tractors subject to Phase 1 standards, manufacturers must create separate vehicle families for vehicles that contain advanced or off-cycle technologies and group those vehicles together in a vehicle family if they use the same advanced or innovative technologies.

(6) *Certifying across service classes.* A manufacturer may optionally certify a tractor to the standards and useful life applicable to a heavier vehicle service class (or regulatory subcategory changes such as complying with the Class 8 day-cab tractor standard instead of Class 7 day-cab tractor), provided the manufacturer does not generate credits with the vehicle. If a manufacturer includes lighter vehicles in a credit-generating subfamily (with an FEL below the standard), exclude their production volume from the credit calculation. Note that if the subfamily is a credit-using subfamily, the manufacturer must include the production volume of the lighter vehicles in the credit calculations.

(7) *Vocational tractors.* Tractors meeting the definition of vocational tractors in 49 CFR 523.2 must comply with requirements for heavy-duty vocational vehicles specified in paragraphs (b) and (d) of this section. Class 7 and Class 8 tractors certified or exempted as vocational tractors are limited in production to no more than 21,000 vehicles in any three consecutive model years. If a manufacturer is determined as not applying this allowance in good faith by EPA in its applications for certification in accordance with 40 CFR 1037.205 and 1037.610, a manufacturer must comply with the tractor fuel consumption standards in paragraph (c)(3) of this section.

(8) *Optional standards.* (i) For Phase 1, manufacturers may use the heavy-duty truck tractor fuel consumption standards given in the following table:

TABLE 13— OPTIONAL TRUCK TRACTOR FUEL CONSUMPTION STANDARDS FOR MODEL YEARS 2013 THROUGH 2019

[Gallons per 1,000 ton-miles]

Regulatory subcategories	Day cab		Sleeper cab
	Class 7	Class 8	Class 8
Model Years 2017 to 2019 Mandatory Standards			
Low Roof	10.2	7.8	6.5
Mid Roof	11.3	8.4	7.2
High Roof	11.8	8.7	7.1
Model Years 2016 Mandatory Standards			
Low Roof	10.5	8	6.7
Mid Roof	11.7	8.7	7.4
High Roof	12.2	9	7.3
Model Years 2013 to 2015 Voluntary Standards			
Low Roof	10.5	8	6.7
Mid Roof	11.7	8.7	7.4

TABLE 13— OPTIONAL TRUCK TRACTOR FUEL CONSUMPTION STANDARDS FOR MODEL YEARS 2013 THROUGH 2019—Continued

[Gallons per 1,000 ton-miles]

Regulatory subcategories	Day cab		Sleeper cab
	Class 7	Class 8	Class 8
High Roof	12.2	9	7.3

(ii) If a manufacturer chooses this option, the fuel consumption rate calculated in accordance with § 535.6(b)(4) must be rounded to the nearest 0.1 gallons per 1,000 ton-miles.

(iii) If a manufacturer chooses this option, it must apply these same standards for each model year from 2013 through 2019.

(9) *Useful life.* The following useful life values apply for the standards of this section:

(i) 185,000 miles or 10 years, whichever comes first, for Class 6 and Class 7 tractors above 19,500 pounds GVWR and at or below 33,000 pounds GVWR for Phase 1 and for Phase 2.

(ii) 435,000 miles or 10 years, whichever comes first, for Class 8 tractors above 33,000 pounds GVWR for Phase 1 and for Phase 2.

(d) *Heavy-duty engines.* Each manufacturer of heavy-duty engines shall comply with the fuel consumption standards in this paragraph (d) of this section expressed in gallons per 100 horsepower-hour. Each engine must be manufactured to comply for its useful life. The provisions of this part apply to all new 2014 model year and later heavy-duty engines. This includes engines fueled by conventional and alternative fuels for engines that will be installed in heavy-duty vehicles above 14,000 pounds GVWR. These provisions also apply for engines that will be installed in heavy-duty glider vehicles at or below 14,000 pounds GVWR Each engine manufactured for use in a heavy-duty tractor or vocational vehicle must be certified to the primary intended service class that it is designed for in accordance with 40 CFR 1036.108 and 1036.140.

(1) *Mandatory standards.* Manufacturers of heavy-duty engines shall comply with the mandatory fuel consumption standards in paragraphs (d)(3) through (6) of this section for model years 2017 and later for compression-ignition engines and for model years 2016 and later for spark-ignition engines.

(i) The heavy-duty engine regulatory category is divided into six regulatory subcategories, five compression-ignition subcategories and one spark-ignition subcategory, as shown in Table 14 of this section.

(ii) Separate standards exist for engines manufactured for use in heavy-duty vocational vehicles and in truck tractors.

(iii) For purposes of certifying engines to fuel consumption standards, manufacturers must divide their product lines in each regulatory subcategory into engine families that have similar fuel consumption features and the same primary intended service class, as specified by EPA in 40 CFR 1036.230, and these families will be subject to the same standards. Each engine family is limited to a single model year.

(2) *Voluntary compliance.* (i) For model years 2013 through 2016 for compression-ignition engines, and for model year 2015 for spark-ignition engines, a manufacturer may choose voluntarily to comply with the fuel consumption standards provided in paragraph (d)(3) through (5) of this section. For example, a manufacturer may choose to comply early in order to begin accumulating credits through over-compliance with the applicable standards. A manufacturer choosing early compliance must comply with all the vehicles and engines it manufacturers in each regulatory category for a given model year except in model year 2013 the manufacturer may comply with individual engine families as specified in 40 CFR 1036.150(a)(2).

(ii) A manufacturer must declare its intent to voluntarily comply with fuel consumption standards and identify its plans to comply before it submits its first application for a certificate of conformity for the respective model year as specified in § 535.8; and, once selected, the decision cannot be reversed and the manufacturer must continue to comply for each subsequent model year for all the vehicles and engines it manufacturers in each regulatory category for a given model year.

(3) *Regulatory subcategory standards.* The primary fuel consumption standards for heavy-duty engines are given in the following table:

TABLE 14—PRIMARY HEAVY-DUTY ENGINE FUEL CONSUMPTION STANDARDS

[Gallons per 100 hp-hr]

Regulatory subcategory	LHD CI engines and all other engines	MHD CI engines and all other engines		HHD CI engines and all other engines		SI engines
Application	Vocational	Vocational	Tractor	Vocational	Tractor	All
Phase 1—Voluntary Standards						
2015	....	....	....	....	....	7.0552
2013 to 2016	5.8939	5.8939	4.9312	5.5697	4.666	....
Phase 1—Mandatory Standards						
2016	....	....	....	....	....	7.0552
2017 to 2020	5.6582	5.6582	4.7839	5.4519	4.5187	7.0552

TABLE 14—PRIMARY HEAVY-DUTY ENGINE FUEL CONSUMPTION STANDARDS—Continued

[Gallons per 100 hp-hr]

Regulatory subcategory	LHD CI engines and all other engines	MHD CI engines and all other engines		HHD CI engines and all other engines		SI engines
Application	Vocational	Vocational	Tractor	Vocational	Tractor	All
Phase 2—Mandatory Standards						
2021 to 2023	5.5501	5.5501	4.7053	5.3438	4.4499	7.0552
2024 to 2026	5.4617	5.4617	4.6071	5.2652	4.3517	7.0552
2027 and later	5.4322	5.4322	4.5776	5.2358	4.3320	7.0552

(4) *Alternate subcategory standards.* The alternative fuel consumption standards for heavy-duty compression-ignition engines are as follows:

(i) Manufacturers entering the voluntary program in model years 2014 through 2016, may choose to certify compression-ignition engine families unable to meet standards provided in paragraph (d)(3) of this section to the alternative fuel consumption standards of this paragraph (d)(4).

(ii) Manufacturers may not certify engines to these alternate standards if they are part of an averaging set in which they carry a balance of banked credits. For purposes of this section, manufacturers are deemed to carry credits in an averaging set if they carry credits from advance technology that are allowed to be used in that averaging set in accordance with § 535.7(d)(12).

(iii) The emission standards of this section are determined as specified by EPA in 40 CFR 1036.620(a) through (c) and should be converted to equivalent fuel consumption values.

(5) *Alternate phase-in standards.* Manufacturers have the option to comply with EPA emissions standards for compression-ignition engines using an alternative phase-in schedule that correlates with EPA's OBD standards. If a manufacturer chooses to use the alternative phase-in schedule for meeting EPA standards and optionally chooses to comply early with the NHTSA fuel consumption program, it must use the same phase-in schedule beginning in model year 2013 for fuel consumption standards and must remain in the program for each model year thereafter until model year 2020. The fuel consumption standard for each model year of the alternative phase-in schedule is provided in Table 15 of this section. Note that engines certified to these standards are not eligible for early credits under § 535.7.

TABLE 15—PHASE 1 ALTERNATIVE PHASE-IN CI ENGINE FUEL CONSUMPTION STANDARDS

[Gallons per 100 hp-hr]

Tractors	LHD engines	MHD engines	HHD engines
Model Years 2013 to 2015	NA	5.0295	4.7642
Model Years 2016 to 2020 †	NA	4.7839	4.5187
Vocational	LHD engines	MHD engines	HHD engines
Model Years 2013 to 2015	6.0707	6.0707	5.6680
Model Years 2016 to 2020†	5.6582	5.6582	5.4519

Note: † These alternate standards for 2016 and later are the same as the otherwise applicable standards through 2020.

(6) *Optional standards.* (i) For model years 2013 through 2020, manufacturers may use heavy-duty engine fuel consumption standards given in the following tables:

TABLE 16—OPTIONAL PRIMARY HEAVY-DUTY ENGINE FUEL CONSUMPTION STANDARDS

[Gallons per 100 hp-hr]

Regulatory subcategory	LHD CI engines	MHD CI engines		HHD CI engines		SI Engines
Application	Vocational	Vocational	Tractor	Vocational	Tractor	All
Mandatory Standards						
Model Years	2017 to 2020					2016 to 2019
Standards	5.66	5.66	4.78	5.45	4.52	7.06
Voluntary Standards						
Model Years	2013 to 2016					2015
Standards	5.89	5.89	4.93	5.57	4.67	7.06

TABLE 17—ALTERNATIVE PHASE-IN CI ENGINE FUEL CONSUMPTION STANDARDS

[Gallons per 100 hp-hr]

Truck Tractors	LHD CI engines	MHD CI engines	HHD CI engines
Model Years 2013 to 2015	NA	5.03	4.76
Model Years 2016 to 2020 †	NA	4.78	4.52
Vocational vehicles	LHD CI Engines	MHD CI Engines	HHD CI Engines
Model Years 2013 to 2015	6.07	6.07	5.67
Model Years 2016 and later †	5.66	5.66	5.45

(ii) If a manufacturer chooses this option, the fuel consumption rate calculated in accordance with § 535.6(c)(4) must be rounded to the nearest 0.01 gallon per 100 hp-hr.

(iii) If a manufacturer chooses this option, it must apply these same standards for each model year from 2013 through 2020.

(7) *Specialty vehicles.* Manufacturers of specialty vehicles as identified in 40 CFR 1037.605 may comply with fuel consumption standards by complying with alternate emission standards that are equivalent to standards that apply for non-road engines as identified in 40 CFR 1037.605, and using § 535.6 and exercising good engineering judgment to determine equivalent fuel consumption standards.

(8) *Alternative fuel conversions.* Engines that have been converted to operate on alternative fuels may demonstrate compliance with the standards of this part or other alternative compliance approaches allowed by EPA in 40 CFR 85.525.

(9) *Useful life.* The following useful life values apply for the standards of this section:

(i) 110,000 miles or 10 years, whichever comes first, for engines used in Class 2b through Class 5 vehicles certified to Phase 1 standards.

(ii) 150,000 miles or 15 years, whichever comes first, for engines used in Class 2b through Class 5 vehicles certified to Phase 2 standards.

(iii) 185,000 miles or 10 years, whichever comes first, for engines used in Class 6 and Class 7 vehicles above 19,500 pounds GVWR and at or below 33,000 pounds GVWR for Phase 1 and for Phase 2.

(iv) 435,000 miles or 10 years, whichever comes first, for engines used in Class 8 vehicles above 33,000 pounds GVWR for Phase 1 and for Phase 2.

(v) For Phase 1 credits that you calculate based on a useful life of 110,000 miles, multiply any banked credits that you carry forward for use into the Phase 2 program by 1.36. For Phase 1 credit deficits that you generate based on a useful life of 110,000 miles multiply the credit deficit by 1.36, if offsetting the shortfall with Phase 2 credits.

(e) *Heavy-duty Trailers.* Each manufacturer of heavy-duty trailers as specified in 49 CFR 523.10, shall comply with the fuel consumption standards in paragraph (e)(1) of this section expressed in gallons per 1000 ton-miles. Each vehicle must be manufactured to comply for its useful life. There are no Phase 1 standards for trailers. Different levels of stringency apply for box vans depending on features that may affect aerodynamic performance.

(1) *Fuel consumption standards.* Trailers manufactured in model year 2021 and later must comply with the fuel consumption standards of this section. For model years 2018 through 2020, trailer manufacturers have the option to voluntarily comply with the fuel consumption standards of this section.

(i) *Non-aero and non-box trailer standards.* Non-aero and non-box trailers must comply with the regulatory subcategory fuel consumption standards in this section.

(A) ''Non-aero trailers'' for trailers 35 feet or longer are box vans that have a rear lift gate or rear hinged ramp, and at least one of the following side features: Side lift gate, belly box, side-mounted pull-out platform, steps for side-door access, or a drop-deck design. ''Non-aero trailers'' for trailers less than 35 feet long are refrigerated box vans with at least one of the side features identified for longer trailers.

(B) Non-box trailers and non-aero trailers must meet the following standards:

(1) Trailers must use qualified automatic tire inflation systems with all load-bearing wheels.

(2) Trailers must use tires with a TRRL at or below 4.7 kg/ton. Through model year 2023, trailers may instead use tires with a TRRL at or below 5.1 kg/ton.

(ii) *Partial-aero trailer standards.* Partial-aero trailers must comply with the regulatory subcategory fuel consumption standards as follows:

(A) ''Partial-aero trailers'' are box vans that have at least one of the side features identified in paragraph (e)(1)(i)(A) of this section. Long box vans also qualify as partial-aero trailers if they have a rear lift gate or rear hinged ramp.

(B) Partial-aero trailers may continue to meet the 2024 standards in 2027 and later model years. This provision does not apply for short refrigerated vans because their standard does not change in 2027.

(iii) *Full-aero trailers.* Full-aero trailers comply with the regulatory subcategory fuel consumption standards as follows:

(A) ''Full-aero trailers'' are box vans that do not meet the specifications for non-areo or partial-aero trailers in paragraph (e)(1)(i)(A) or (e)(1)(ii)(A) of this section.

(B) Fuel consumption standards apply for full-aero trailers as specified in the following table:

TABLE 18—PHASE 2 FUEL AERO TRAILER FUEL CONSUMPTION STANDARDS

[Gallons per 1,000 ton-miles]

Model years	Dry van		Refrigerated van	
	Long	Short	Long	Short
Voluntary Standards				
2018 to 2020	8.1532	14.1454	8.2515	14.4401

TABLE 18—PHASE 2 FUEL AERO TRAILER FUEL CONSUMPTION STANDARDS—Continued

[Gallons per 1,000 ton-miles]

Model years	Dry van		Refrigerated van	
	Long	Short	Long	Short
Mandatory Standards				
2021 to 2023	7.9568	13.9489	8.0550	14.3418
2024 to 2026	7.7603	13.8507	7.9568	14.1454
2027 and later	7.5639	13.7525	7.8585	14.1454

(C) For purposes of certifying vehicles to fuel consumption standards, manufacturers must divide their product lines into vehicles families that have similar emissions and fuel consumption features, as specified by EPA in 40 CFR part 1037.230, and these families will be subject to the applicable standards. Each vehicle family is limited to a single model year.

(2) *Subfamily standards.* Manufacturers may specify a Family Emission Limit (FEL) in terms of fuel consumption for each vehicle subfamily. The FEL may not be less than the result of fuel consumption modeling from 40 CFR 1037.520. The FEL is the fuel consumption standard for the vehicle subfamily instead of the standard specified in paragraph (e)(1)(ii) and (iii) of this section and can be used for calculating fuel consumption credits in accordance with § 535.7. Manufacturers may not use averaging for non-box trailers, partial-aero trailers, or non-aero trailers that meet standards under paragraph (e)(1) of this section, and may not use fuel consumption credits for banking or trading for any trailers.

(3) *Useful life.* The fuel consumption standards of this section apply for a useful life equal to 10 years.

§ 535.6 Measurement and calculation procedures.

Determine all vehicle parameters used for testing in accordance with EPA's provisions in 40 CFR 1037.140. Manufacturers conducting testing for certification or annual demonstration testing and providing CO_2 emissions data to EPA must also provide equivalent fuel consumption results for all values. NHTSA and EPA reserve the right to verify separately or in coordination the results of any testing and measurement established by manufacturers in complying with the provisions of this program and as specified in 40 CFR 1037.301 and § 535.9. Any carry over data from the Phase 1 program may be carried into the Phase 2 only with approval from EPA and by using good engineering judgment considering differences in test protocols for testing procedure.

(a) *Heavy-duty pickup trucks and vans.* This section describes the testing a manufacturer must perform for each model year and the method for determining the fleet fuel consumption performance to show compliance with the fleet average fuel consumption standard for heavy-duty pickup trucks and vans in § 535.5(a).

(1) For each model year, the heavy-duty pickup trucks and vans selected by a manufacturer to comply with fuel consumption standards in § 535.5(a) must be used to determine the manufacturer's fleet average fuel consumption performance. If the manufacturer's fleet includes conventional and advanced technology heavy-duty pickup trucks and vans, the fleet should be sub-divided into two separate vehicle fleets, with all of the conventional vehicles in one fleet and all of the advanced technology vehicles in the other fleet.

(2) Vehicles in each fleet should be divided into test groups or subconfigurations according to EPA in 40 CFR part 86, subpart S.

(3) Test and measure the CO_2 emissions test results for the selected vehicles and determine the CO_2 emissions test group result, in grams per mile in accordance with 40 CFR part 86, subpart S.

(i) Perform exhaust testing on vehicles fueled by conventional and alternative fuels, including dedicated and dual-fueled (multi-fuel and flexible-fuel) vehicles and measure the CO_2 emissions test result.

(ii) Adjust the CO_2 emissions test result of dual-fueled vehicles using a weighted average of your emission results as specified in 40 CFR 600.510–12(k) for light-duty trucks.

(iii) All electric vehicles are deemed to have zero emissions of CO_2, CH_4, and N_2O. No emission testing is required for such electric vehicles. Assign the fuel consumption test group result to a value of zero gallons per 100 miles in paragraph (a)(4) of this section.

(iv) Test cab-complete and incomplete vehicles using the applicable complete sister vehicles as determined in 40 CFR part 86.

(v) Test loose engines using applicable complete vehicles as determined in 40 CFR part 86.

(vi) Manufacturers can choose to analytically derive CO_2 emission rates (ADCs) for test groups or subconfigurations. Calculate the ADCs for test groups or subconfigurations in accordance with 40 CFR 86.1819–14 (g).

(4) Calculate equivalent fuel consumption test group results, in gallons per 100 miles, from CO_2 emissions test group results, in grams per miles, and round to the nearest 0.001 gallon per 100 miles.

(i) Calculate the equivalent fuel consumption test group results as follows for compression-ignition vehicles and alternative fuel compression-ignition vehicles. CO_2 emissions test group result (grams per mile)/10,180 grams per gallon of diesel fuel) $\times$ (10^2) = Fuel consumption test group result (gallons per 100 mile).

(ii) Calculate the equivalent fuel consumption test group results as follows for spark-ignition vehicles and alternative fuel spark-ignition vehicles. CO_2 emissions test group result (grams per mile)/8,877 grams per gallon of gasoline fuel) $\times$ (10^2) = Fuel consumption test group result (gallons per 100 mile).

(5) Calculate the fleet average fuel consumption result, in gallons per 100 miles, from the equivalent fuel consumption test group results and round the fuel consumption result to the nearest 0.001 gallon per 100 miles. Calculate the fleet average fuel consumption result using the following equation.

$$\text{Fleet Average Fuel Consumption} = \frac{\sum\left[\text{Fuel Consumption Test Group Result}_i \times \text{Volume}_i\right]}{\sum\left[\text{Volume}_i\right]}$$

Where:

Fuel Consumption Test Group Result$_i$ = fuel consumption performance for each test group as defined in 49 CFR 523.4.

Volume$_i$ = production volume of each test group.

(6) Compare the fleet average fuel consumption standard to the fleet average fuel consumption performance. The fleet average fuel consumption performance must be less than or equal to the fleet fuel consumption standard to comply with standards in § 535.5(a).

(b) *Heavy-duty vocational vehicles and tractors.* This section describes the testing a manufacturer must perform and the method for determining fuel consumption performance to show compliance with the fuel consumption standards for vocational vehicles and tractors in § 535.5(b) and (c).

(1) Select vehicles and vehicle family configurations to test as specified in 40 CFR 1037.230 for vehicles that make up each of the manufacturer's regulatory subcategories of vocational vehicles and tractors.

(2) Determine the CO_2 emissions and fuel consumption results for all vehicles(conventional, alternative fueled and advanced technology vehicles) using the Greenhouse Emissions Model (GEM) in accordance with 40 CFR part 1037, subpart F. Vocational vehicles and tractors are modeled using the following inputs in the GEM model.

(3) For Phase 1, all of the following GEM inputs apply for sleeper cab tractors, and day cab tractors. Some do not apply for vocational vehicles and other tractor regulatory subcategories, as follows:

(i) Manufacturers must identify vehicles according to their regulatory subcategory, as defined in § 535.4, for use in GEM (such as ''Class 8 Combination—Sleeper Cab—High Roof'').

(ii) Coefficient of aerodynamic drag in accordance with 40 CFR 1037.520 and 1037.525. Do not use for vocational vehicles.

(iii) Steer tire rolling resistance for low rolling resistance tires in accordance with 40 CFR 1037.520 and 1037.650.

(iv) Drive tire rolling resistance for low rolling resistance tires in accordance with 40 CFR 1037.520 and 1037.650.

(v) Vehicle speed limit as governed by vehicles speed limiters in accordance with 40 CFR 1037.520 and 1037.640. Do not use for vocational vehicles.

(vi) Vehicle weight reduction as provided in accordance with 40 CFR 1037.520. Do not use for vocational vehicles.

(vii) Extended idle reduction credit using automatic engine shutdown systems in accordance with 40 CFR 1037.520 and 1037.660. Do not use for vehicles other than Class 8 sleeper cabs.

(4) For Phase 1, engine performance and the advanced technologies equipped on vocational vehicles and tractors are tested separately as follows:

(i) Test results for engines installed in vocational vehicles and tractors, for both conventional and alternative fueled vehicles, are determined in accordance with paragraph (c) of this section.

(ii) Improvements for advanced technologies are determined as follows:

(A) Test hybrid vehicles with power take-off in accordance with 40 CFR 1037.540.

(B) Vehicles with post-transmission hybrid systems are determined in accordance with 40 CFR 1037.550.

(5) For Phase 2, manufacturers are allowed to add additional specifications to improve fuel consumption performance in GEM as specified in 40 CFR 1037.520. Additional GEM inputs apply for Phase 2 tractors and vocational vehicles as follows:

(i) Transmission make, model, type, and the gear ratio for every available forward gears.

(ii) Engine make, model, fuel type, engine family name, calibration identification. Also identify whether the engine is subject to spark-ignition or compression-ignition standards under 40 CFR part 1036.

(iii) Drive axle ratio. If a vehicle is designed with two or more user-selectable axle ratios, use the axle ratio that is expected to be engaged for the greatest driving distance.

(iv) Various engine and vehicle operational characteristics, as described in 40 CFR 1037.520(f).

(v) Engine fuel maps, which include an idle fuel map for vocational vehicles.

(vi) Engine full-load torque curve and motoring torque curve.

(vii) Loaded tire radius, based upon nominal design specifications, expressed to the nearest 0.01m as described in 40 CFR 1037.140.

(viii) Hybrid power take-off (for vocational vehicles only).

(6) Manufacturers may certify their vehicles based on powertrain testing as described in 40 CFR 1037.550, rather than fuel maps, to characterize fuel consumption rates at different speed and torque values.

(7) Emergency vehicles complying with alternative standards specified in § 535.5(b) and 40 CFR 1037.105(b)(4), run GEM by identifying the vehicle as an emergency vehicle and enter values for tire rolling resistance only.

(8) You may use a default fuel map for specialty vehicles using engines certified to alternate standards under 40 CFR 1037.605.

(9) Manufacturers of vehicles that run on fuel other than gasoline or diesel, should use good engineering judgment to adjust modeling output values to account for the physical properties of the fuel.

(10) From the GEM results, select the CO_2 family emissions level (FEL) and equivalent fuel consumption values for vocational vehicle and tractor families in each regulatory subcategory for each model year. Equivalent fuel consumption FELs are derived in GEM and expressed to the nearest 0.0001 gallons per 1000 ton-mile. For families containing multiple subfamilies, identify the FELs for each subfamily.

(11) All electric vehicles are deemed to have zero CO_2 emissions and fuel consumption. No emission testing is required for such electric vehicles. Assign the vehicle family with a fuel consumption FEL result to a value of zero gallons per 1000-ton miles.

(c) [Reserved]

(d) *Heavy-duty engines.* This section describes the testing a manufacturer must perform and the method for determining fuel consumption performance to show compliance with the fuel consumption standards for engines in § 535.5(d). Each engine must be tested to the primary intended service class that it is designed for in accordance with 40 CFR 1036.108. For engines using aftertreatment technology with infrequent regeneration events test in accordance with 40 CFR 86.004–28,

(1) Manufacturers must select emission-data engines and engine family configurations to test as specified in 40 CFR part 86 for engines in heavy-duty pickup trucks and vans and 40 CFR 1036.235 for engines installed in truck tractors and vocational vehicles that make up each of the manufacture's regulatory subcategories.

(2) Test the CO_2 emissions for each emissions-data engine subject to the

standards in § 535.5(d) using the procedures and equipment specified in 40 CFR part 1036, subpart F. Measure the CO_2 emissions in grams per hp-hr as specified in 40 CFR 1036.501. For medium and heavy heavy-duty engines certified as tractor engines, measure CO_2 emissions using the steady-state duty cycle specified in 40 CFR 86.1362. For medium and heavy heavy-duty engines certified as both tractor and vocational engines, measure CO_2 emissions using the steady-state duty cycle and the transient duty cycle (sometimes referred to as the FTP engine cycle), both of which are specified in 40 CFR part 86, subpart N.

(i) Perform exhaust testing on each fuel type for conventional, dedicated, dual-fueled (multi-fuel, and flexible-fuel) vehicles and measure the CO_2 emissions level as specified in 40 CFR part 1036.

(ii) Adjust the CO_2 emissions result of dual-fueled vehicles using a weighted average of the demonstrated emission results as specified in 40 CFR 1036.225. If EPA disapproves a manufacturer's dual-fueled vehicle demonstrated use submission, NHTSA will require the manufacturer to only use the test results with 100 percent conventional fuel to determine the fuel consumption of the engine.

(iii) All electric vehicles are deemed to have zero emissions of CO_2 and zero fuel consumption. No emission or fuel consumption testing is required for such electric vehicles.

(3) Determine the CO_2 emissions for the family certification level (FCL) from the emissions test results in paragraph (c)(2) of this section for engine families within the heavy-duty engine regulatory subcategories for each model year.

(i) If a manufacturer certifies an engine family for use both as a vocational engine and as a tractor engine, the manufacturer must split the family into two separate subfamilies in accordance with 40 CFR 1036.230. The manufacturer may assign the numbers and configurations of engines within the respective subfamilies at any time prior to the submission of the end-of-year report required by 40 CFR 1036.730 and § 535.8. The manufacturer must track into which type of vehicle each engine is installed, although EPA may allow the manufacturer to use statistical methods to determine this for a fraction of its engines.

(ii) The following engines are excluded from the engine families used to determined FCL values and the benefit for these engines is determined as an advanced technology credit under the ABT provisions provided in § 535.7(e); these provisions apply only for the Phase 1 program:

(A) Engines certified as hybrid engines or power packs.

(B) Engines certified as hybrid engines designed with PTO capability and that are sold with the engine coupled to a transmission.

(C) Engines with Rankine cycle waste heat recovery.

(4) Calculate equivalent fuel consumption values for emissions FCLs and the CO_2 levels for certified engines, in gallons per 100 hp-hr and round each fuel consumption value to the nearest 0.0001 gallon per 100 hp-hr.

(i) Calculate equivalent fuel consumption FCL values for compression-ignition engines and alternative fuel compression-ignition engines. CO_2 FCL value (grams per hp-hr)/10,180 grams per gallon of diesel fuel) x (10^2) = Fuel consumption FCL value (gallons per 100 hp-hr).

(ii) Calculate equivalent fuel consumption FCL values for spark-ignition engines and alternative fuel spark-ignition engines. CO_2 FCL value (grams per hp-hr)/8,877 grams per gallon of gasoline fuel) x (10^2) = Fuel consumption FCL value (gallons per 100 hp-hr).

(iii) Manufacturers may carryover fuel consumption data from a previous model year if allowed to carry over emissions data for EPA in accordance with 40 CFR 1036.235.

(iv) If a manufacturer uses an alternate test procedure under 40 CFR 1065.10 and subsequently the data is rejected by EPA, NHTSA will also reject the data.

(e) *Heavy-duty trailers.* This section describes the testing a manufacturer must perform and the method for determining fuel consumption performance to show compliance with the fuel consumption standards for trailers in § 535.5(e).

(1) Select trailer family configurations to test as specified in 40 CFR 1037.235 for trailers that make up each of the manufacture's regulatory subcategories of heavy-duty trailers.

(2) Obtain preliminary approvals for trailers aerodynamic devices from EPA in accordance with 40 CFR 1037.150.

(3) For manufacturers voluntarily complying in model years 2018 through 2020, and for trailers complying with mandatory standards in model years 2021 and later, determine the CO_2 emissions and fuel consumption results for partial- and full-aero trailers using the equations and technologies specified in CFR part 1037, subpart F. Use testing to determine input values in accordance with 40 CFR 1037.515.

(4) Non-box trailers and non-aero trailers certified using design-based certification must meet tire rolling resistance levels, and use tire inflation systems on all load-bearing wheels as prescribed in 40 CFR 1037.150.

(5) Box trailer manufacturers shall use a GEM-based equation to calculate CO_2 emissions, as specified in 40 CFR 1037.515. From the equation results, calculate the CO_2 family emissions level (FEL) and equivalent fuel consumption values for trailer families in the long dry van, short dry van, long refrigerated van, and short refrigerated van regulatory subcategories for each model year. Equivalent fuel consumption FELs are expressed to the nearest 0.0001 gallons per 1000 ton-mile. For families containing multiple subfamilies, identify the FELs for each subfamily.

§ 535.7 Averaging, banking, and trading (ABT) credit program.

(a) *General provisions.* After the end of each model year, manufacturers must comply with the fuel consumption standards in § 535.5 by averaging, banking and trading credits. Trailer manufacturers are excluded from this section except for those producing full-aero box trailers, which may comply with special provisions in paragraph (e) of this section. Manufacturers comply with standards if the sum of averaged, banked and traded credits generate a ''zero'' credit balance or a credit surplus within an averaging set of vehicles or engines. Manufacturers fail to comply with standards if the sum of the credit flexibilities generate a credit deficit (or shortfall) in an averaging set. Credit shortfalls must be offset by banked or traded credits within three model years after the shortfall is incurred. These processes are hereafter referenced as the NHTSA ABT credit program. The following provisions apply to all fuel consumption credits.

(1) *Credits (or fuel consumption credits (FCCs)).* Credits in this part mean a calculated weighted value representing the difference between the fuel consumption performance and the standard of a vehicle or engine family or fleet within a particular averaging set. Positive credits represent cases where a vehicle or engine family or fleet perform better than the applicable standard (the fuel consumption performance is less than the standard) whereas negative credits represent underperforming cases. The value of a credit is calculated according to sections (b) through (e) of this section. FCCs are only considered earned or useable for averaging, banking or trading after EPA and NHTSA have verified the information in a manufacturer's final reports required in § 535.8. Types of FCCs include the following:

(i) *Conventional credits.* Credits generated by vehicle or engine families or fleets containing conventional vehicles (*i.e.,* gasoline, diesel and alternative fueled vehicles).

(ii) *Early credits.* Credits generated by vehicle or engine families or fleets produced for model year 2013. Early credits are multiplied by an incentive factor of 1.5 times.

(iii) *Advanced technology credits.* Credits generated by vehicle or engine families or subconfigurations containing vehicles with advanced technologies (*i.e.,* hybrids with regenerative braking, vehicles equipped with Rankine-cycle engines, electric and fuel cell vehicles) and incentivized under this ABT credit program in paragraph (f)(1) of this section and by EPA under 40 CFR 86.1819–14(d)(7), 1036.615, and 1037.615.

(iv) *Innovative and off-cycle technology credits.* Credits generated by vehicle or engine families or subconfigurations having fuel consumption reductions resulting from technologies not reflected in the GEM simulation tool or in the FTP chassis dynomometer. These innovative and off-cycle technology are incentivized under this fuel consumption program in paragraph (f)(2) of this section and by EPA under 40 CFR 86.1819–14(d)(13), 1036.610, and 1037.610.

(2) *Averaging.* Averaging is the summing of a manufacturer's positive and negative FCCs for engines or vehicle families or fleets within an averaging set. The principle averaging sets are defined in § 535.4.

(i) A credit surplus occurs when the net sum of the manufacturer's generated credits for engines or vehicle families or fleets within an averaging set is positive (a zero credit balance is when the sum equals zero).

(ii) A credit deficit occurs when the net sum of the manufacturer's generated credits for engines or vehicle families or fleets within an averaging set is negative.

(iii) Positive credits, other than advanced technology credits, generated and calculated within an averaging set may only be used to offset negative credits within the same averaging set.

(iv) Manufacturers may certify one or more vehicle families (or subfamilies) to an FEL above the applicable fuel consumption standard, subject to any applicable FEL caps and other provisions allowed by EPA in 40 CFR parts 1036 and 1037, if the manufacturer shows in its application for certification to EPA that its projected balance of all FCC transactions in that model year is greater than or equal to zero or that a negative balance is allowed by EPA under 40 CFR 1036.745 and 1037.745.

(v) If a manufacturer certifies a vehicle family to an FEL that exceeds the otherwise applicable standard, it must obtain enough FCC to offset the vehicle family's deficit by the due date of its final report required in § 535.8. The emission credits used to address the deficit may come from other vehicle families that generate FCCs in the same model year (or from the next three subsequent model years), from banked FCCs from previous model years, or from FCCs generated in the same or previous model years that it obtained through trading. Note that the option for using banked or traded credits does not apply for trailers.

(vi) Manufacturers may certify a vehicle or engine family using an FEL (as described in § 535.6) below the fuel consumption standard (as described in § 535.5) and choose not to generate conventional fuel consumption credits for that family. Manufacturers do not need to calculate fuel consumption credits for those families and do not need to submit or keep the associated records described in § 535.8 for these families. Manufacturers participating in NHTSA's FCC program must provide reports as specified in § 535.8.

(3) *Banking.* Banking is the retention of surplus FCC in an averaging set by the manufacturer for use in future model years for the purpose of averaging or trading.

(i) Surplus credits may be banked by the manufacturer for use in future model years, or traded, given the restriction that the credits have an expiration date of five model years after the year in which the credits are generated. For example, banked credits earned in model year 2014 may be utilized through model year 2019. Surplus credits will become banked credits unless a manufacturer contacts NHTSA to expire its credits.

(ii) Surplus credits become earned or usable banked FCCs when the manufacturer's final report is approved by both agencies. However, the agencies may revoke these FCCs at any time if they are unable to verify them after reviewing the manufacturer's reports or auditing its records.

(iii) Banked FCC retain the designation from the averaging set and model year in which they were generated.

(iv) Banked credits retain the designation of the averaging set in which they were generated.

(v) Trailer manufacturers generating credits in paragraph (e) of this section may not bank credits except to resolve credit deficits in the same model year or from up to three prior model years.

(4) *Trading.* Trading is a transaction that transfers banked FCCs between manufacturers or other entities in the same averaging set. A manufacturer may use traded FCCs for averaging, banking, or further trading transactions.

(i) Manufacturers may only trade banked credits to other manufacturers with vehicle or engines in the same averaging set. Traded FCCs, other than advanced technology credits, may be used only within the averaging set in which they were generated. Manufacturers may only trade credits to other entities for the purpose of expiring credits.

(ii) Advanced technology credits can be traded across different averaging sets.

(iii) The agencies may revoke traded FCCs at any time if they are unable to verify them after reviewing the manufacturer's reports or auditing its records.

(iv) If a negative FCC balance results from a transaction, both the buyer and seller are liable, except in cases the agencies deem to involve fraud. See § 535.9 for cases involving fraud. EPA also may void the certificates of all vehicle families participating in a trade that results in a manufacturer having a negative balance of emission credits. See 40 CFR 1037.745.

(v) Trailer manufacturers generating credits in paragraph (e) of this section may not trade credits.

(5) *Credit deficit (or credit shortfall).* A credit shortfall or deficit occurs when the sum of the manufacturer's generated credits for engines or vehicle families or fleets within an averaging set is negative. Credit shortfalls must be offset by an available credit surplus within three model years after the shortfall was incurred. If the shortfall cannot be offset, the manufacturer is liable for civil penalties as discussed in § 535.9.

(6) *FCC transaction plan.* In order to provide the maximum flexibility to a manufacturer, during the model year and before the due date for its final report, an FCC transaction plan must be submitted to the agencies as specified in § 535.8 anytime a manufacturer wants to executes a credit transaction involving banked or tradeding credits. For example, if a manufacturer executes a plan to apply banked credits over multiple subsequent model years.

(7) *Revoked credits.* NHTSA may revoke fuel consumption credits if unable to verify any information after auditing reports or records or conducting conformitory testing. In the cases where EPA revokes emissions CO_2 credits, NHTSA will revoke the same amount of fuel consumption credits.

(b) *ABT provisions for heavy-duty pickup trucks and vans.* (1) Calculate fuel consumption credits in a model year for one fleet of conventional heavy-duty pickup trucks and vans and if designated by the manufacturer another consisting of advance technology vehicles for the averaging set as defined in § 535.4. Calculate credits for each fleet separately using the following equation:

Total MY Fleet FCC (gallons) = (Std − Act) x (Volume) x (UL) x (10^2)

Std = Fleet average fuel consumption standard (gal/100 mile).
Act = Fleet average actual fuel consumption value (gal/100 mile).
Volume = the total U.S.-directed production of vehicles in the regulatory subcategory.
UL = the useful life for the regulatory subcategory. The useful life value for heavy-pickup trucks and vans manufactured for model years 2013 through 2020 is equal to the 120,000 miles. The useful life for model years 2021 and later is equal to 150,000 miles.

(2) Adjust the fuel consumption performance of subconfigurations with advanced technology for determining the fleet average actual fuel consumption value as specified in paragraph (f)(1) of this section and 40 CFR 86.1819–14(d)(7). Advanced technology vehicles can be separated in a different fleet for the purpose of applying credit incentives as described in paragraph (f)(1) of this section.

(3) Adjust the fuel consumption performance for subconfigurations with innovative technology. A manufacturer is eligible to increase the fuel consumption performance of heavy-duty pickup trucks and vans in accordance with procedures established by EPA set forth in 40 CFR part 600. The eligibility of a manufacturer to increase its fuel consumption performance through use of an off-cycle technology requires an application request made to EPA and NHTSA in accordance with 40 CFR 86.1869–12 and an approval granted by the agencies. For off-cycle technologies that are covered under 40 CFR 86.1869–12, NHTSA will collaborate with EPA regarding NHTSA's evaluation of the specific off-cycle technology to ensure its impact on fuel consumption and the suitability of using the off-cycle technology to adjust fuel consumption performance. NHTSA will provide its views on the suitability of the technology for that purpose to EPA. NHTSA will apply the criteria in section (f) of this section in granting or denying off-cycle requests.

(4) Fuel consumption credits may be generated for vehicles certified in model year 2013 to the model year 2014 standards in § 535.5(a). If a manufacturer chooses to generate CO_2 emission credits under EPA's provisions in 40 CFR part 86, it may also voluntarily generate early credits under the NHTSA fuel consumption program. To do so, a manufacturer must certify its entire U.S.-directed production volume of vehicles in its fleet. The same production volume restrictions specified in 40 CFR 1037.150(a)(2) relating to when test groups are certified apply to the NHTSA early credit provisions. Credits are calculated as specified in paragraph (b)(3) of this section relative to the fleet standard that would apply for model year 2014 using the model year 2013 production volumes. Surplus credits generated under this paragraph (b)(4) are available for banking or trading. Credit deficits for an averaging set prior to model year 2014 do not carry over to model year 2014. These credits may be used to show compliance with the standards of this part for 2014 and later model years. Once a manufacturer opts into the NHTSA program they must stay in the program for all of the optional model years and remain standardized with the same implementation approach being followed to meet the EPA CO_2 emission program.

(5) Calculate the averaging set credit value by summing together the fleet credits for conventional and advanced technology vehicles including any adjustments for innovative technologies. Manufacturers may sum conventional and innovative technology credits before adding any advanced technology credits in each averaging set.

(6) Credit adjustment for useful life. For credits that manufacturers calculate based on a useful life of 120,000 miles, multiply any banked credits carried forward for use in model year 2021 and later by 1.25. For credit deficits that you calculate based on a useful life of 120,000 miles and that you offset with credits originally earned in model year 2021 and later, multiply the credit deficit by 1.25.

(c) *ABT provisions for vocational vehicles and tractors.* (1) Calculate the fuel consumption credits in a model year for each participating family or subfamily consisting of conventional vehicles in each averaging set (as defined in § 535.4) using the equation in this section. Each designated vehicle family or subfamily has a ''family emissions limit'' (FEL) that is compared to the associated regulatory subcategory standard. An FEL that falls below the regulatory subcategory standard creates ''positive credits,'' while fuel consumption level of a family group above the standard creates a ''negative credits.'' The value of credits generated for each family or subfamily in a model year is calculated as follows:

Vehicle Family FCC (gallons) = (Std − FEL) x (Payload) x (Volume) x (UL) x (10^3)

Where:
Std = the standard for the respective vehicle family regulatory subcategory (gal/1000 ton-mile).
FEL = family emissions limit for the vehicle family (gal/1000 ton-mile).
Payload = the prescribed payload in tons for each regulatory subcategory as shown in the following table:

Regulatory subcategory	Payload (tons)
LHD Vocational Vehicles	2.85
MHD Vocational Vehicles	5.60
HHD Vocational Vehicles	7.5
Class 7 Tractor	12.50
Class 8 Tractor	19.00

Volume = the number of U.S.-directed production volume of vehicles in the corresponding vehicle family.
UL = the useful life for the regulatory subcategory (miles) as shown in the following table:

Regulatory subcategory	UL (miles)
LHD Vocational Vehicles	110,000 (Phase 1), 150,000 (Phase 2).
MHD Vocational Vehicles	185,000.
HHD Vocational Vehicles	435,000.
Class 7 Tractor	185,000.
Class 8 Tractor	435,000.

(i) Calculate the value of credits generated in a model year for each family or subfamily consisting of vehicles with advanced technology vehicles in each averaging set using the equation above and the guidelines provided in paragraph (f)(1) of this section. Manufacturers may generate credits for advanced technology vehicles using incentives specified in paragraph (f)(1) of this section.

(ii) Calculate the value of credits generated in a model year for each family or subfamily consisting of vehicles with off-cycle technology vehicles in each averaging set using the equation above and the guidelines provided in paragraph (f)(2) of this section.

(2) Manufacturers must sum all negative and positive credits for each vehicle family within each applicable averaging set to obtain the total credit balance for the model year before rounding. The sum of fuel consumptions credits must be rounded to the nearest gallon. Calculate the total

credits generated in a model year for each averaging set using the following equation:

Total averaging set MY credits = Σ Vehicle family credits within each averaging set

(3) Manufacturers can sum conventional and innovative technology credits before adding any advanced technology credits in each averaging set.

(4) If a manufacturer chooses to generate CO_2 emission credits under EPA provisions of 40 CFR 1037.150(a), it may also voluntarily generate early credits under the NHTSA fuel consumption program as follows:

(i) Fuel consumption credits may be generated for vehicles certified in model year 2013 to the model year 2014 standards in § 535.5(b) and (c). To do so, a manufacturer must certify its entire U.S.-directed production volume of vehicles. The same production volume restrictions specified in 40 CFR 1037.150(a)(1) relating to when test groups are certified apply to the NHTSA early credit provisions. Credits are calculated as specified in paragraph (c)(11) of this section relative to the standards that would apply for model year 2014. Surplus credits generated under this paragraph (c)(4) may be increased by a factor of 1.5 for determining total available credits for banking or trading. For example, if you have 10 gallons of surplus credits for model year 2013, you may bank 15 gallons of credits. Credit deficits for an averaging set prior to model year 2014 do not carry over to model year 2014. These credits may be used to show compliance with the standards of this part for 2014 and later model years. Once a manufacturer opts into the NHTSA program they must stay in the program for all of the optional model years and remain standardized with the same implementation approach being followed to meet the EPA CO_2 emission program.

(ii) A tractor manufacturer may generate fuel consumption credits for the number of additional SmartWay designated tractors (relative to its MY 2012 production), provided that credits are not generated for those vehicles under paragraph (c)(4)(i) of this section. Calculate credits for each regulatory sub-category relative to the standard that would apply in model year 2014 using the equations in paragraph (c)(2) of this section. Use a production volume equal to the number of verified model year 2013 SmartWay tractors minus the number of verified model year 2012 SmartWay tractors. A manufacturer may bank credits equal to the surplus credits generated under this paragraph multiplied by 1.50. A manufacturer's 2012 and 2013 model years must be equivalent in length. Once a manufacturer opts into the NHTSA program they must stay in the program for all of the optional model years and remain standardized with the same implementation approach being followed to meet the EPA CO_2 emission program.

(5) If a manufacturer generates credits from vehicles certified for advanced technology in accordance with paragraph (e)(1) of this section, a multiplier of 1.5 can be used, but this multiplier cannot be used on the same credits for which the early credit multiplier is used.

(d) *ABT provisions for heavy-duty engines.* (1) Calculate the fuel consumption credits in a model year for each participating family or subfamily consisting of engines in each averaging set (as defined in § 535.4) using the equation in this section. Each designated engine family has a ''family certification level'' (FCL) which is compared to the associated regulatory subcategory standard. A FCL that falls below the regulatory subcategory standard creates ''positive credits,'' while fuel consumption level of a family group above the standard creates a ''credit shortfall.'' The value of credits generated in a model year for each engine family or subfamily is calculated as follows:

$$\text{Engine Family FCC (gallons)} = (\text{Std} - \text{FCL}) \times (\text{CF}) \times (\text{Volume}) \times (\text{UL}) \times (10^2)$$

Where:

Std = the standard for the respective engine regulatory subcategory (gal/100 hp-hr).

FCL = family certification level for the engine family (gal/100 hp-hr).

CF= a transient cycle conversion factor in hp-hr/mile which is the integrated total cycle horsepower-hour divided by the equivalent mileage of the applicable test cycle. For spark-ignition heavy-duty engines, the equivalent mileage is 6.3 miles. For compression-ignition heavy-duty engines, the equivalent mileage is 6.5 miles.

Volume = the number of engines in the corresponding engine family.

UL = the useful life of the given engine family (miles) as shown in the following table:

Regulatory subcategory	UL (miles)
Class 2b-5 Vocational Vehicles, Spark Ignited (SI), and Light Heavy-Duty Diesel Engines.	110,000 (Phase 1), 150,000 (Phase 2).
Class 6–7 Vocational Vehicles and Medium Heavy-Duty Diesel Engines.	185,000.
Class 8 Vocational Vehicles and Heavy Heavy-Duty Diesel Engines.	435,000.
Class 7 Tractors and Medium Heavy-Duty Diesel Engines.	185,000.
Class 8 Tractors and Heavy Heavy-Duty Diesel Engines.	435,000.

(i) Calculate the value of credits generated in a model year for each family or subfamily consisting of engines with advanced technology vehicles in each averaging set using the equation above and the guidelines provided in paragraph (f)(1) of this section. Manufacturers may generate credits for advanced technology vehicles using incentives specified in paragraph (f)(1) of this section.

(ii) Calculate the value of credits generated in a model year for each family or subfamily consisting of engines with off-cycle technology vehicles in each averaging set using the equation above and the guidelines provided in paragraph (f)(2) of this section.

(2) Manufacturers shall sum all negative and positive credits for each engine family within the applicable averaging set to obtain the total credit balance for the model year before rounding. The sum of fuel consumptions credits should be rounded to the nearest gallon. Calculate the total credits generated in a model year for each averaging set using the following equation:

Total averaging set MY credits = Σ Engine family credits within each averaging set

(3) The provisions of this section apply to manufacturers utilizing the compression-ignition engine voluntary alternate standard provisions specified in § 535.5(d)(4) as follows:

(i) Manufacturers may not certify engines to the alternate standards if they are part of an averaging set in which they carry a balance of banked credits. For purposes of this section, manufacturers are deemed to carry credits in an averaging set if they carry credits from advance technology that are allowed to be used in that averaging set.

(ii) Manufacturers may not bank fuel consumption credits for any engine family in the same averaging set and model year in which it certifies engines to the alternate standards. This means a manufacturer may not bank advanced technology credits in a model year it certifies any engines to the alternate standards.

(iii) Note that the provisions of paragraph (a) of this section apply with respect to credit deficits generated while utilizing alternate standards.

(4) Where a manufacturer has chosen to comply with the EPA alternative compression ignition engine phase-in standard provisions in 40 CFR 1036.150(e), and has optionally decided to follow the same path under the NHTSA fuel consumption program, it must certify all of its model year 2013 compression-ignition engines within a given averaging set to the applicable alternative standards in § 535.5(d)(5). Engines certified to these standards are not eligible for early credits under paragraph (d)(5) of this section. Credits are calculated using the same equation provided in paragraph (d)(1) of this section.

(5) If a manufacturer chooses to generate early CO_2 emission credits under EPA provisions of 40 CFR 1036.150, it may also voluntarily generate early credits under the NHTSA fuel consumption program. Fuel consumption credits may be generated for engines certified in model year 2013 (2015 for spark-ignition engines) to the standards in § 535.5(d). To do so, a manufacturer must certify its entire U.S.-directed production volume of engines except as specified in 40 CFR 1036.150(a)(2). Credits are calculated as specified in paragraph (d)(1) of this section relative to the standards that would apply for model year 2014 (2016 for spark-ignition engines). Surplus credits generated under this paragraph (d)(3) may be increased by a factor of 1.5 for determining total available credits for banking or trading. For example, if you have 10 gallons of surplus credits for model year 2013, you may bank 15 gallons of credits. Credit deficits for an averaging set prior to model year 2014 (2016 for spark-ignition engines) do not carry over to model year 2014 (2016 for spark-ignition engines). These credits may be used to show compliance with the standards of this part for 2014 and later model years. Once a manufacturer opts into the NHTSA program they must stay in the program for all of the optional model years and remain standardized with the same implementation approach being followed to meet the EPA CO_2 emission program.

(e) *ABT provisions for trailers.* (1) Manufacturers can not use averaging for non-box trailers, partial-aero trailers, or non-aero trailers and can not use fuel consumption credits for banking or trading for any trailers. Full aero box trailer manufactures may average credits but cannot bank credits except to resolve deficits in future model years.

(2) Calculate the fuel consumption credits in a model year for each participating family or subfamily consisting of full aero box trailers (vehicles) in each averaging set (as defined in § 535.4) using the equation in this section. Each designated vehicle family or subfamily has a ''family emissions limit'' (FEL) which is compared to the associated regulatory subcategory standard. An FEL that falls below the regulatory subcategory standard creates ''positive credits,'' while fuel consumption level of a family group above the standard creates a ''negative credits.'' The value of credits generated for each family or subfamily in a model year is calculated as follows:

$$\text{Vehicle Family FCC (gallons)} = (\text{Std} - \text{FEL}) \times (\text{Payload}) \times (\text{Volume}) \times (\text{UL}) \times (10^3)$$

Where:

Std = the standard for the respective vehicle family regulatory subcategory (gal/1000 ton-mile).

FEL = family emissions limit for the vehicle family (gal/1000 ton-mile).

Payload = 19 tons.

Volume = the number of U.S.-directed production volume of vehicles in the corresponding vehicle family.

UL = the useful life for the regulatory subcategory. The useful life value for heavy-duty trailers is equal to the 250,000 miles.

(3) Trailer manufacturers may not generate advanced or innovative technology credits.

(4) Manufacturers shall sum all negative and positive credits for each vehicle family within the applicable averaging set to obtain the total credit balance for the model year before rounding. The sum of fuel consumptions credits should be rounded to the nearest gallon.

Calculate the total credits generated in a model year for each averaging set using the following equation:

$$\text{Total averaging set MY credits} = \Sigma \text{ Vehicle family credits within each averaging set}$$

(5) Trailer manufacturers may not generate a credit surplus within an averaging set for the purpose of banking except to offset a credit deficit from a prior model year.

(f) *Additional credit provisions.* (1) *Advanced technology credits.* Manufacturers of heavy-duty pickup trucks and vans, vocational vehicles, tractors and the associated engines showing improvements in CO_2 emissions and fuel consumption using hybrid vehicles with regenerative braking, vehicles equipped with Rankine-cycle engines, electric vehicles and fuel cell vehicles are eligible for advanced technology credits. Manufacturers shall use sound engineering judgment to determine the performance of the vehicle or engine with advanced techonology. Advanced technology credits for vehicles or engines complying with Phase 1 standards may be increased by a 1.5 multiplier for Phase 2. Manufacturers may not apply this multiplier in addition to any early-credit multipliers. The maximum amount of credits a manufacturer may bring into the service class group that contains the heavy-duty pickup and van averaging set is $5.89 \cdot 10^6$ gallons (for advanced technology credits based upon compression ignition engines) or $6.76 \cdot 10^6$ gallons (for advanced technology credits based upon spark-ignition engines) per model year as specified in 40 CFR part 86 for heavy-duty pickup trucks and vans, 40 CFR 1036.740 for engines and 40 CFR 1037.740 for tractors and vocational vehicles. The specified limit does not cap the amount of advanced technology credits that can be used across averaging sets within the same service class group. Advanced technology credits can be used to offset negative credits in the same averaging set or other averaging sets. A manufacturer must first apply advanced technology credits to any deficits in the same averaging set before applying them to other averaging.

(i) *Heavy-duty pickup trucks and vans.* For advanced technology systems (hybrid vehicles with regenerative braking, vehicles equipped with Rankine-cycle engines and fuel cell vehicles), calculate fleet-average performance rates consistent with good engineering judgment and the provisions of 40 CFR 86.1819–14 and 40 CFR 86.1865.

(ii) *Tractors and vocational vehicles.* For advanced technology system (hybrid vehicles with regenerative braking, vehicles equipped with Rankine-cycle engines and fuel cell vehicles), calculate the advanced technology credits as follows:

(A) Measure the effectiveness of the advanced system by conducting A to B testing a vehicle equipped with the advanced system and an equivalent conventional system in accordance with 40 CFR 1037.615.

(B) For purposes of this paragraph (e), a conventional vehicle is considered to be equivalent if it has the same footprint, intended vehicle service class, aerodynamic drag, and other relevant factors not directly related to the advanced system powertrain. If there is no equivalent vehicle, the manufacturer may create and test a prototype equivalent vehicle. The conventional vehicle is considered Vehicle A, and the advanced technology vehicle is considered Vehicle B.

(C) The benefit associated with the advanced system for fuel consumption is determined from the weighted fuel consumption results from the chassis tests of each vehicle using the following equation:

Benefit (gallon/1000 ton mile) = Improvement Factor × GEM Fuel Consumption Result_B

Where:

Improvement Factor = (Fuel Consumption_A − Fuel Consumption_B)/(Fuel Consumption_A)

Fuel Consumption Rates A and B are the gallons per 1000 ton-mile of the conventional and advanced vehicles, respectively as measured under the test procedures specified by EPA.

GEM Fuel Consumption Result B is the estimated gallons per 1000 ton-mile rate resulting from emission modeling of the advanced vehicle as specified in 40 CFR 1037.520 and § 535.6(b).

(D) Calculate the benefit in credits using the equation in paragraph (c) of this section and replacing the term (Std-FEL) with the benefit.

(E) For electric vehicles calculate the fuel consumption credits using an FEL of 0 g/1000ton-mile.

(iii) *Heavy-duty engines.* (A) This section specifies how to generate advanced technology-specific fuel consumption credits for hybrid powertrains that include energy storage systems and regenerative braking (including regenerative engine braking) and for engines that include Rankine-cycle (or other bottoming cycle) exhaust energy recovery systems.

(*1*) Pre-transmission hybrid powertrains are those engine systems that include features that recover and store energy during engine motoring operation but not from the vehicle wheels. These powertrains are tested using the hybrid engine test procedures of 40 CFR part 1065 or using the post-transmission test procedures.

(*2*) Post-transmission hybrid powertrains are those powertrains that include features that recover and store energy from braking at the vehicle wheels. These powertrains are tested by simulating the chassis test procedure applicable for hybrid vehicles under 40 CFR 1037.550.

(*3*) Test engines that include Rankine-cycle exhaust energy recovery systems according to the test procedures specified in 40 CFR part 1036, subpart F, unless EPA approves the manufacturer's alternate procedures.

(B) Calculate credits as specified in paragraph (c) of this section. Credits generated from engines and powertrains certified under this section may be used in other averaging sets as described in 40 CFR 1036.740(d).

(2) *Innovative and off-cycle technology credits.* This provision allows fuel saving innovative and off-cycle engine and vehicle technologies to generate fuel consumption credits comparable to CO_2 emission credits consistent with the provisions of 40 CFR 1036.610 (for engines), 40 CFR part 86 (for heavy-duty pickup trucks and vans) and 40 CFR 1037.610 (for vocational vehicles and tractors).

(i) For model years 2013 through 2020, manufacturers may generate innovative technology credits for introducing technologies that were not in-common use for heavy-duty vehicles or engines before model year 2010 and that are not reflected in the EPA specified test procedures. Upon identification and joint approval with EPA, NHTSA will allow equivalent fuel consumption credits into its program to those allowed by EPA for manufacturers seeking to obtain innovative technology credits in a given model year. Such credits must remain within the same regulatory subcategory in which the credits were generated. NHTSA will adopt fuel consumption credits depending upon whether—

(A) The technology has a direct impact upon reducing fuel consumption performance; and

(B) The manufacturer has provided sufficient information to make sound engineering judgments on the impact of the technology in reducing fuel consumption performance.

(ii) For model years 2021 and later, manufacturers may generate off-cycle technology credits for introducing technologies that are not reflected in the EPA specified test procedures. Upon identification and joint approval with EPA, NHTSA will allow equivalent fuel consumption credits into its program to those allowed by EPA for manufacturers seeking to obtain innovative technology credits in a given model year. Such credits must remain within the same regulatory subcategory in which the credits were generated. NHTSA will adopt fuel consumption credits depending upon whether—

(A) The technology meets paragraph (f)(2)(i)(A) and (B) of this section.

(B) For heavy-duty pickup trucks and vans, manufacturers using the 5-cycle test to quantify the benefit of a technology are not required to obtain approval from the agencies to generate results.

(iii) The following provisions apply to all innovative and off-cycle technologies:

(A) Technologies found to be defective, or identified as a part of NHTSA's safety defects program, and technologies that are not performing as intended will have the values of approved off-cycle credits removed from the manufacturer's credit balance.

(B) Approval granted for innovative and off-cycle technology credits under NHTSA's fuel efficiency program does not affect or relieve the obligation to comply with the Vehicle Safety Act (49 U.S.C. Chapter 301), including the ''make inoperative'' prohibition (49 U.S.C. 30122), and all applicable Federal motor vehicle safety standards issued thereunder (FMVSSs) (49 CFR part 571). In order to generate off-cycle or innovative technology credits manufacturers must state—

(1) That each vehicle equipped with the technology for which they are seeking credits will comply with all applicable FMVSS(s); and

(2) Whether or not the technology has a fail-safe provision. If no fail-safe provision exists, the manufacturer must explain why not and whether a failure of the innovative technology would affect the safety of the vehicle.

(C) Manufacturers requesting approval for innovative technology credits are required to provide documentation in accordance with 40 CFR 86.1869–12, 1036.610, and 1037.610.

(D) Credits will be accepted on a one-for-one basis expressed in terms of gallons in comparison to those approved by EPA.

(E) For the heavy-duty pickup trucks and vans, the average fuel consumption will be calculated as a separate credit amount (rounded to the nearest whole number) using the following equation:

Off-cycle FC credits = (CO_2 Credit/CF) × 100 × Production × VLM

Where:

CO_2 Credits = the credit value in grams per mile determined in 40 CFR 86.1869–12(c)(3), (d)(1), (d)(2) or (d)(3).

CF = conversion factor, which for spark ignition engines is 8,887 and for compression ignition engines is 10,180.

Production = the total production volume for the applicable category of vehicles

VLM = vehicle lifetime miles, which for 2b-3 vehicles shall be 150,000 for the Phase 2 program.

(F) NHTSA will not approve innovative technology credits for technology that is related to crash-avoidance technologies, safety critical systems or systems affecting safety-critical functions, or technologies designed for the purpose of reducing the frequency of vehicle crashes.

(iv) Manufacturers may carryover an approved innovative technology into the Phase 2 off-cycle credit program. Manufacturers may continue to carryover the improvement factor (not the credit value) if—

(A) The FEL is generated by GEM or 5-cycle testing;

(B) The technology is not changed or paired with any other off-cycle technology;

(C) The improvement factor only applies to approved vehicle or engine families;

(D) The agencies do not expect the technology to be incorporated into GEM at any point during the Phase 2 program; and

(E) The documentation to carryover credits that would primarily justify the difference in fuel efficiency between real world and compliance protocols is the same for both Phase 1 and Phase 2 compliance protocols. The agencies must approve the justification. If the agencies do not approve the justification, the manufacturer must recertify.

§ 535.8 Reporting and recordkeeping requirements.

(a) *General requirements.* Manufacturers producing heavy-duty vehicles and engines applicable to fuel consumption standards in § 535.5, for each given model year, must submit the required information as specified in paragraphs (b) through (h) of this section.

(1) The information required by this part must be submitted by the deadlines specified in this section and must be based upon all the information and data available to the manufacturer 30 days before submitting information.

(2) Manufacturers must submit information electronically through the EPA database system as the single point of entry for all information required for this national program and both agencies will have access to the information. The format for the required information is specified by EPA in coordination with NHTSA.

(3) Manufacturers providing incomplete reports missing any of the required information or providing untimely reports are considered as not complying with standards (*i.e.,* if good-faith estimates of U.S.-directed production volumes for EPA certificates of conformity are not provided) and are liable to pay civil penalties in accordance with 49 U.S.C. 32912.

(4) Manufacturers certifying a vehicle or engine family using an FEL or FCL below the applicable fuel consumption standard as described in § 535.5 may choose not to generate fuel consumption credits for that family. In which case, the manufacturer is not required to submit reporting or keep the associated records described in this part for that family.

(5) Manufacturers must use good engineering judgment and provide comparable fuel consumption information to that of the information or data provided to EPA under 40 CFR 86.1865, 1036.250, 1036.730, 1036.825 1037.250, 1037.730, and 1037.825.

(6) Any information that must be sent directly to NHTSA. In instances in which EPA has not created an electronic pathway to receive the information, the information should be sent through an electronic portal identified by NHTSA or through the NHTSA CAFE database (*i.e.,* information on fuel consumption credit transactions). If hardcopy documents must be sent, the information should be sent to the Associate Administrator of Enforcement at 1200 New Jersey Avenue, NVS–200, Office W45–306, SW., Washington, DC 20590.

(b) *Pre-model year reports.* Manufacturers producing heavy-duty pickup trucks and vans must submit reports in advance of the model year providing early estimates demonstrating how their fleet(s) would comply with GHG emissions and fuel consumption standards. Note, the agencies understand that early model year reports contain estimates that may change over the course of a model year and that compliance information manufacturers submit prior to the beginning of a new model year may not represent the final compliance outcome. The agencies view the necessity for requiring early model reports as a manufacturer's good faith projection for demonstrating compliance with emission and fuel consumption standards.

(1) *Report deadlines.* For model years 2013 and later, manufacturer of heavy-duty pickup trucks and vans complying with voluntary and mandatory standards must submit a pre-model year report for the given model year as early as the date of the manufacturer's annual certification preview meeting with EPA and NHTSA, or prior to submitting its first application for a certificate of conformity to EPA in accordance with 40 CFR 86.1819–14 (d). For example, a manufacturer choosing to comply in model year 2014 could submit its pre-model year report during its precertification meeting which could occur before January 2, 2013, or could provide its pre-model year report any time prior to submitting its first application for certification for the given model year.

(2) *Contents.* Each pre-model year report must be submitted including the following information for each model year.

(i) A list of each unique subconfiguration in the manufacturer's fleet describing the make and model designations, attribute based-values (*i.e.,* GVWR, GCWR, Curb Weight and drive configurations) and standards;

(ii) The emission and fuel consumption fleet average standard derived from the unique vehicle configurations;

(iii) The estimated vehicle configuration, test group and fleet production volumes;

(iv) The expected emissions and fuel consumption test group results and fleet average performance;

(v) If complying with MY 2013 fuel consumption standards, a statement must be provided declaring that the manufacturer is voluntarily choosing to comply early with the EPA and NHTSA programs. The manufacturers must also acknowledge that once selected, the decision cannot be reversed and the manufacturer will continue to comply with the fuel consumption standards for subsequent model years for all the vehicles it manufacturers in each regulatory category for a given model year;

(vi) If complying with MYs 2014, 2015 or 2016 fuel consumption standards, a statement must be provided declaring whether the manufacturer will use fixed or increasing standards in accordance with § 535.5(a). The manufacturer must also acknowledge that once selected, the decision cannot be reversed and the manufacturer must continue to comply with the same alternative for subsequent model years for all the vehicles it manufacturers in each regulatory category for a given model year;

(vii) If complying with MYs 2014 or 2015 fuel consumption standards, a statement must be provided declaring that the manufacturer is voluntarily choosing to comply with NHTSA's voluntary fuel consumption standards in accordance with § 535.5(a)(4). The manufacturers must also acknowledge that once selected, the decision cannot be reversed and the manufacturer will continue to comply with the fuel consumption standards for subsequent model years for all the vehicles it manufacturers in each regulatory category for a given model year;

(viii) The list of Class 2b and 3 incomplete vehicles (cab-complete or chassis complete vehicles) and the method used to certify these vehicles as complete pickups and vans identifying the most similar complete sister- or other complete vehicles used to derive the target standards and performance test results;

(ix) The list of Class 4 and 5 incomplete and complete vehicles and the method use to certify these vehicles as complete pickups and vans identifying the most similar complete or sister vehicles used to derive the target standards and performance test results;

(x) List of loose engines included in the heavy-duty pickup and van category and the list of vehicles used to derive target standards and performance test results;

(xi) Copy of any notices a vehicle manufacturer sends to the engine manufacturer to notify the engine manufacturers that their engines are subject to emissions and fuel consumption standards and that it intends to use their engines in excluded vehicles;

(xii) A credit plan identifying the manufacturers estimated credit balances, planned credit flexibilities (*i.e.,* credit balances, planned credit trading, innovative, advanced and early credits and etc.) and if needed a credit deficit plan demonstrating how it plans to resolve any credit deficits that might occur for a model year within a period of up to three model years after that deficit has occurred; and

(xiii) The supplemental information specified in paragraph (h) of this section. [**Note:** NHTSA may also ask a manufacturer to provide additional information if necessary to verify compliance with the fuel consumption requirements of this regulation.]

(c) *Applications for certificate of conformity.* Manufacturers producing vocational vehicles, tractors and heavy-duty engines are required to submit applications for certificates of conformity to EPA in accordance with 40 CFR 1036.205 and 1037.205 in advance of introducing vehicles for commercial sale. Applications contain early model year information demonstrating how manufacturers plan to comply with GHG emissions. For model years 2013 and later, manufacturers of vocational vehicles, tractors and engine complying with NHTSA's voluntary and mandatory standards must submit applications for certificates of conformity in accordance through the EPA database including both GHG emissions and fuel consumption information for each given model year.

(1) *Submission deadlines.* Applications are primarily submitted in advance of the given model year to EPA but cannot be submitted any later than December 31 of the given model year.

(2) *Contents.* Each application for certificates of conformity submitted to EPA must include the following equivalent fuel consumption.

(i) Equivalent fuel consumption values for emissions CO_2 FCLs values used to certify each engine family in accordance with 40 CFR 1036.205(e). This provision applies only to manufacturers producing heavy-duty engines.

(ii) Equivalent fuel consumption values for emission CO_2 data engines used to comply with emission standards in 40 CFR 1036.108. This provision applies only to manufacturers producing heavy-duty engines.

(iii) Equivalent fuel consumption values for emissions CO_2 FELs values used to certify each vehicle families or subfamilies in accordance with 40 CFR 1037.205(k). This provision applies only to manufacturers producing vocational vehicles and tractors.

(iv) Report modeling results for ten configurations in terms of CO_2 emissions and equivalent fuel consumption results in accordance with 40 CFR 1037.205(o). Include modeling inputs and detailed descriptions of how they were derived. This provision applies only to manufacturers producing vocational vehicles and tractors.

(3) *Additional supplemental information.* Manufacturers are required to submit additional information as specified in paragraph (h) of this section for the NHTSA program before or at the same time it submits its first application for a certificate of conformity to EPA. Under limited conditions, NHTSA may also ask a manufacturer to provide additional information directly to the Administrator if necessary to verify the fuel consumption requirements of this regulation.

(d) *Final reports.* Heavy-duty vehicle and engine manufacturers participating and not-participating in the ABT program are required to submit an end-of-the-year (EOY) report containing information for NHTSA as specified in paragraph (d)(2) of this section and in accordance with 40 CFR 86.1865, 1036.730, and 1037.730. The final reports are used to review a manufacturer's preliminary or final compliance information and to identify manufacturers that might have a credit deficit for the given model year. For model years 2013 and later, heavy-duty vehicle and engine manufacturers complying with NHTSA's voluntary and mandatory standards must submit final reports through the EPA database including both GHG emissions and fuel consumption information for each given model year.

(1) *Report deadlines.* For model year 2013 and later, heavy-duty vehicle and engine manufacturers complying with NHTSA voluntary and mandatory standards must submit EOY reports through the EPA database including both GHG emissions and fuel consumption information within 90 days after the end of the given model year and no later than April 1 of the next calendar year. For example, the final report for model year 2014 must be submitted no later than April 1, 2015. A manufacturer may ask NHTSA and EPA to extend the deadline of a final report by up to 30 days. A manufacturer unable to provide, and requesting to omit an emissions rate or fuel consumption value from a final report must obtain approval from the agencies prior to the submission deadline of its final report.

(i) If a manufacturer expects differences in the information reported between the EOY and the final year report specified in 40 CFR 1036.730 and 1037.730, it must provide the most up-to-date fuel consumption projections in its final report and identify the information as preliminary.

(ii) If the manufacturer cannot provide any of the required fuel consumption information, it must state the specific reason for the insufficiency and identify the additional testing needed or explain what analytical methods are believed by the manufacturer will be necessary to eliminate the insufficiency and certify that the results will be available for the final report.

(2) *Contents.* Each final report must be submitted including the following fuel consumption information for each model year. final reports for manufacturers participating in the ABT program must include final estimates.

(i) Engine and vehicle family designations and averaging sets.

(ii) Engine and vehicle regulatory subcategory and fuel consumption standards including any alternative standards used.

(iii) Engine and vehicle family FCLs and FELs in terms of fuel consumption.

(iv) Final production volumes for engines and vehicles.

(v) A final credit plan (for manufacturers participating in the ABT program) identifying the manufacturers actual fuel consumption credit balances, credit flexibilities, credit trades and a credit deficit plan if needed demonstrating how it plans to resolve any credit deficits that might occur for a model year within a period of up to three model years after that deficit has occurred.

(vi) A summary as specified in paragraph (g)(7) of this section describing the vocational vehicles and vocational tractors that were exempted as heavy-duty off-road vehicles. This applies to manufacturers participating and not participating in the ABT program.

(vii) A summary describing any advanced or innovative technology engines or vehicles including alternative fueled vehicles that were produced for the model year identifying the approaches used to determine compliance and the production volumes.

(viii) A list of each unique subconfiguration included in a manufacturer's fleet of heavy-duty pickup trucks and vans identifying the attribute based-values (GVWR, GCWR, Curb Weight, and drive configurations) and standards. This provision applies only to manufacturers producing heavy-duty pickup trucks and vans.

(ix) The fuel consumption fleet average standard derived from the unique vehicle configurations. This provision applies only to manufacturers producing heavy-duty pickup trucks and vans.

(x) The subconfiguration and test group production volumes. This provision applies only to manufacturers producing heavy-duty pickup trucks and vans.

(xi) The fuel consumption test group results and fleet average performance. This provision applies only to manufacturers producing heavy-duty pickup trucks and vans.

(xii) Under limited conditions, NHTSA may also ask a manufacturer to provide additional information directly to the Administrator if necessary to verify the fuel consumption requirements of this regulation.

(e) *Amendments to applications for certification.* At any time, a manufacturer modifies an application for certification in accordance with 40 CFR 1036.225 and 1037.225, it must submit GHG emissions changes with equivalent fuel consumption values for the information required in paragraphs (b) through (e) and (h) of this section.

(f) *Confidential information.* Manufacturers must submit a request for confidentiality with each electronic submission specifying any part of the for information or data in a report that it believes should be withheld from *public* disclosure as trade secret or other confidential business information. Information submitted to EPA should follow EPA guidelines for treatment of confidentiality. Requests for confidential treatment for information submitted to NHTSA must be filed in accordance with the requirements of 49 CFR part 512, including submission of a request for confidential treatment and the information for which confidential treatment is requested as specified by part 512. For any information or data requested by the manufacturer to be withheld under 5 U.S.C. 552(b)(4) and 49 U.S.C. 32910(c), the manufacturer shall present arguments and provide evidence in its request for confidentiality demonstrating that–

(1) The item is within the scope of 5 U.S.C. 552(b)(4) and 49 U.S.C. 32910(c);

(2) The disclosure of the information at issue would cause significant competitive damage;

(3) The period during which the item must be withheld to avoid that damage; and

(4) How earlier disclosure would result in that damage.

(g) *Additional required information.* The following additional information is required to be submitted through the EPA database. NHTSA reserves the right to ask a manufacturer to provide additional information if necessary to verify the fuel consumption requirements of this regulation.

(1) *Small businesses.* For model years 2013 through 2020, vehicles and engines produced by small business manufacturers meeting the criteria in 13 CFR 121.201 are exempted from the requirements of this part. Qualifying small business manufacturers must notify EPA and NHTSA Administrators before importing or introducing into U.S. commerce exempted vehicles or engines. This notification must include a description of the manufacturer's qualification as a small business under 13 CFR 121.201. Manufacturers must submit this notification to EPA, and EPA will provide the notification to NHTSA. The agencies may review a manufacturer's qualification as a small business manufacturer under 13 CFR 121.201.

(2) *Emergency vehicles.* For model years 2021 and later, emergency vehicles produced by heavy-duty pickup truck and van manufacturers are exempted except those produced by manufacturers voluntarily complying with standards in § 535.5(a). Manufacturers must notify the agencies in writing if using the provisions in § 535.5(a) to produce exempted emergency vehicles in a given model year, either in the report specified in 40 CFR 86.1865 or in a separate submission.

(3) *Early introduction.* The provision applies to manufacturers seeking to comply early with the NHTSA's fuel consumption program prior to model year 2014. The manufacturer must send the request to EPA before submitting its first application for a certificate of conformity.

(4) *NHTSA voluntary compliance model years.* Manufacturers must submit a statement declaring whether the manufacturer chooses to comply voluntarily with NHTSA's fuel consumption standards for model years 2014 through 2015. The manufacturers must acknowledge that once selected, the decision cannot be reversed and the manufacturer will continue to comply with the fuel consumption standards for subsequent model years. The manufacturer must send the statement to EPA before submitting its first application for a certificate of conformity.

(5) *Alternative engine standards.* Manufacturers choosing to comply with the alternative engine standards must notify EPA and NHTSA of their choice and include in that notification a demonstration that it has exhausted all available credits and credit opportunities. The manufacturer must send the statement to EPA before submitting its EOY report.

(6) *Alternate phase-in.* Manufacturers choosing to comply with the alternative engine phase-in must notify EPA and NHTSA of their choice. The manufacturer must send the statement to EPA before submitting its first application for a certificate of conformity.

(7) *Off-road exclusion (tractors, vocational vehicles and trailers only).* (i) Tractors and vocational vehicles intended to be used extensively in off-road environments such as forests, oil fields, and construction sites may be exempted without request from the requirements of this regulation as specified in 49 CFR 523.2 and § 535.5(b). Within 90 days after the end of each model year, manufacturers must send EPA and NHTSA through the EPA database a report with the following information:

(A) A description of each excluded vehicle configuration, including an explanation of why it qualifies for this exclusion.

(B) The number of vehicles excluded for each vehicle configuration.

(ii) A manufacturer having an off-road vehicle failing to meet the criteria under the agencies' off-road exclusions will be allowed to request an exclusion of such a vehicle from EPA and NHTSA. The approval will be granted through the certification process for the vehicle family and will be done in collaboration between EPA and NHTSA in accordance with the provisions in 40 CFR 1037.150, 1037.210, and 1037.630.

(8) *Vocational tractors.* Tractors intended to be used as vocational tractors may comply with vocational vehicle standards in § 535.5(b) of this regulation. Manufacturers classifying tractors as vocational tractors must provide a description of how they meet

the qualifications in their applications for certificates of conformity as specified in 40 CFR 1037.205.

(9) *Approval of alternate methods to determine drag coefficients (tractors only).* Manufacturers seeking to use alternative methods to determine aerodynamic drag coefficients must provide a request and gain approval by EPA in accordance with 40 CFR 1037.525. The manufacturer must send the request to EPA before submitting its first application for a certificate of conformity.

(10) *Innovative and off-cycle technology credits.* Manufacturers pursuing innovative and off-cycle technology credits must submit information to the agencies and may be subject to a public evaluation process in which the public would have opportunity for comment if the manufacturer is not using a test procedure in accordance with 40 CFR 1037.610(c). Whether the approach involves on-road testing, modeling, or some other analytical approach, the manufacturer would be required to present a final methodology to EPA and NHTSA. EPA and NHTSA would approve the methodology and credits only if certain criteria were met. Baseline emissions and fuel consumption and control emissions and fuel consumption would need to be clearly demonstrated over a wide range of real world driving conditions and over a sufficient number of vehicles to address issues of uncertainty with the data. Data would need to be on a vehicle model-specific basis unless a manufacturer demonstrated model-specific data was not necessary. The agencies may publish a notice of availability in the **Federal Register** notifying the public of a manufacturer's proposed alternative off-cycle credit calculation methodology and provide opportunity for comment. Any notice will include details regarding the methodology, but not include any Confidential Business Information.

(11) *Credit trades.* If a manufacturer trades fuel consumption credits, it must send EPA and NHTSA a fuel consumption credit plan as specified in § 535.7(a) and provide the following information within 90 days after the transaction:

(i) As the seller, the manufacturer must include the following information in its report:

(A) The corporate names of the buyer and any brokers.

(B) A copy of any contracts related to the trade.

(C) The fleet, vehicle or engine families that generated fuel consumption credits for the trade, including the number of fuel consumption credits from each family.

(ii) As the buyer, the manufacturer or entity must include the following information in its report:

(A) The corporate names of the seller and any brokers.

(B) A copy of any contracts related to the trade.

(C) How the manufacturer or entity intends to use the fuel consumption credits, including the number of fuel consumption credits it intends to apply to each vehicle family (if known).

(D) A copy of the contract with signatures from both the buyer and the seller.

(12) *Production reports.* Within 90 days after the end of the model year, manufacturers must send to EPA a report including the total U.S.-directed production volume of vehicles it produced in each vehicle and engine family during the model year (based on information available at the time of the report) as required by 40 CFR 1036.250 and 40 CFR 1037.250. Each manufacturer shall report by vehicle or engine identification number and by configuration and identify the subfamily identifier. Report uncertified vehicles sold to secondary vehicle manufacturers. Small business manufacturers may omit reporting. Identify any differences between volumes included for EPA but excluded for NHTSA.

(h) *Public information.* Based upon information submitted by manufacturers and EPA, NHTSA will publish fuel consumption standards and performance results.

(i) *Information received from EPA.* NHTSA will receive information from EPA as specified in 40 CFR 1036.755 and 1037.755.

(j) *Recordkeeping.* NHTSA has the same recordkeeping requirements as EPA, specified in 40 CFR 86.1865–12(k), 1036.250, 1036.735, 1036.825, 1037.250, 1037.735, and 1037.825. The agencies each reserve the right to request information contained in records separately. If collected separately and NHTSA finds that information is provided fraudulent or grossly negligent or otherwise provided in bad faith, the manufacturer may be liable to civil penalties in accordance with each agencies authority.

§ 535.9 Enforcement approach.

(a) *Compliance.* (1) Each year NHTSA will assess compliance with fuel consumption standards as specified in § 535.10.

(i) NHTSA may conduct audits or verification testing prior to first sale throughout a given model year or after the model year in order to validate data received from manufacturers and will discuss any potential issues with EPA and the manufacturer. Audits may periodically be performed to confirm manufacturers credit balances or other credit transactions.

(ii) NHTSA may also conduct field inspections either at manufacturing plants or at new vehicle dealerships to validate data received from manufacturers. Field inspections will be carried out in order to validate the condition of vehicles, engines or technology prior to first commercial sale to verify each component's certified configuration as initially built. NHTSA reserves the right to conduct inspections at other locations but will target only those components for which a violation would apply to OEMs and not the fleets or vehicle owners. Compliance inspections could be carried out through a number of approaches including during safety inspections or during compliance safety testing.

(iii) NHTSA will conduct audits and inspections in the same manner and, when possible, in conjunction with EPA. NHTSA will also attempt to coordinate inspections with EPA and share results.

(iv) Documents collected under NHTSA safety authority may be used to support fuel efficiency audits and inspections.

(2) At the end of each model year NHTSA will confirm a manufacturer's fleet or family performance values against the applicable standards and, if a manufacturer uses a credit flexibility, the amount of credits in each averaging set. The averaging set balance is based upon the engines or vehicles performance above or below the applicable regulatory subcategory standards in each respective averaging set and any credits that are traded into or out of an averaging set during the model year.

(i) If the balance is positive, the manufacturer is designated as having a credit surplus.

(ii) If the balance is negative, the manufacturer is designated as having a credit deficit.

(iii) NHTSA will provide notification to each manufacturer confirming its credit balance(s) after the end of each model year directly or through EPA.

(3) Manufacturer are required to confirm the negative balance and submit a fuel consumption credit plan as specified in § 535.7(a) along with supporting documentation indicating how it will allocate existing credits or earn (providing information on future vehicles, engines or technologies), and/or acquire credits, or else be liable for

a civil penalty as determined in paragraph (b) of this section. The manufacturer must submit the information within 60 days of receiving agency notification.

(4) Credit shortfall within an averaging set may be carried forward only three years, and if not offset by earned or traded credits, the manufacturer may be liable for a civil penalty as described in paragraph (b) of this section.

(5) Credit allocation plans received from a manufacturer will be reviewed and approved by NHTSA. NHTSA will approve a credit allocation plan unless it determines that the proposed credits are unavailable or that it is unlikely that the plan will result in the manufacturer earning or acquiring sufficient credits to offset the subject credit shortfall. In the case where a manufacturer submits a plan to acquire future model year credits earned by another manufacturer, NHTSA will require a signed agreement by both manufacturers to initiate a review of the plan. If a plan is approved, NHTSA will revise the respective manufacturer's credit account accordingly by identifying which existing or traded credits are being used to address the credit shortfall, or by identifying the manufacturer's plan to earn future credits for addressing the respective credit shortfall. If a plan is rejected, NHTSA will notify the respective manufacturer and request a revised plan. The manufacturer must submit a revised plan within 14 days of receiving agency notification. The agency will provide a manufacturer one opportunity to submit a revised credit allocation plan before it initiates civil penalty proceedings.

(6) For purposes of this regulation, NHTSA will treat the use of future credits for compliance, as through a credit allocation plan, as a deferral of civil penalties for non-compliance with an applicable fuel consumption standard.

(7) If NHTSA receives and approves a manufacturer's credit allocation plan to earn future credits within the following three model years in order to comply with regulatory obligations, NHTSA will defer levying civil penalties for non-compliance until the date(s) when the manufacturer's approved plan indicates that credits will be earned or acquired to achieve compliance, and upon receiving confirmed CO_2 emissions and fuel consumption data from EPA. If the manufacturer fails to acquire or earn sufficient credits by the plan dates, NHTSA will initiate civil penalty proceedings.

(8) In the event that NHTSA fails to receive or is unable to approve a plan for a non-compliant manufacturer due to insufficiency or untimeliness, NHTSA may initiate civil penalty proceedings.

(9) In the event that a manufacturer fails to report accurate fuel consumption data for vehicles or engines covered under this rule, noncompliance will be assumed until corrected by submission of the required data, and NHTSA may initiate civil penalty proceedings.

(10) If EPA suspends or revoke a certificate of conformity as specified in 40 CFR 1036.255 or 1037.255, and a manufacturer is unable to take a corrective action allowed by EPA, noncompliance will be assumed, and NHTSA may initiate civil penalty proceedings or revoke fuel consumption credits.

(b) *Civil penalties*—(1) *Generally.* NHTSA may assess a civil penalty for any violation of this part under 49 U.S.C. 32902(k). This section states the procedures for assessing civil penalties for violations of § 535.3(h). The provisions of 5 U.S.C. 554, 556, and 557 do not apply to any proceedings conducted pursuant to this section.

(2) *Initial determination of noncompliance.* An action for civil penalties is commenced by the execution of a Notice of Violation. A determination by NHTSA's Office of Enforcement of noncompliance with applicable fuel consumption standards utilizing the certified and reported CO_2 emissions and fuel consumption data provided by the Environmental Protection Agency as described in this part, and after considering all the flexibilities available under § 535.7, underlies a Notice of Violation. If NHTSA Enforcement determines that a manufacturer's averaging set of vehicles or engines fails to comply with the applicable fuel consumption standard(s) by generating a credit shortfall, the incomplete vehicle, complete vehicle or engine manufacturer, as relevant, shall be subject to a civil penalty.

(3) *Numbers of violations and maximum civil penalties.* Any violation shall constitute a separate violation with respect to each vehicle or engine within the applicable regulatory averaging set. The maximum civil penalty is not more than $37,500.00 per vehicle or engine. The maximum civil penalty under this section for a related series of violations shall be determined by multiplying $37,500.00 times the vehicle or engine production volume for the model year in question within the regulatory averaging set. NHTSA may adjust this civil penalty amount to account for inflation.

(4) *Factors for determining penalty amount.* In determining the amount of any civil penalty proposed to be assessed or assessed under this section, NHTSA shall take into account the gravity of the violation, the size of the violator's business, the violator's history of compliance with applicable fuel consumption standards, the actual fuel consumption performance related to the applicable standards, the estimated cost to comply with the regulation and applicable standards, the quantity of vehicles or engines not complying, and the effect of the penalty on the violator's ability to continue in business. The ''estimated cost to comply with the regulation and applicable standards,'' will be used to ensure that penalties for non-compliance will not be less than the cost of compliance.

(5) *NHTSA enforcement report of determination of non-compliance.* (i) If NHTSA Enforcement determines that a violation has occurred, NHTSA Enforcement may prepare a report and send the report to the NHTSA Chief Counsel.

(ii) The NHTSA Chief Counsel will review the report prepared by NHTSA Enforcement to determine if there is sufficient information to establish a likely violation.

(iii) If the Chief Counsel determines that a violation has likely occurred, the Chief Counsel may issue a Notice of Violation to the party.

(iv) If the Chief Counsel issues a Notice of Violation, he or she will prepare a case file with recommended actions. A record of any prior violations by the same party shall be forwarded with the case file.

(6) *Notice of violation.* (i) The Notice of Violation will contain the following information:

(A) The name and address of the party;

(B) The alleged violation(s) and the applicable fuel consumption standard(s) violated;

(C) The amount of the proposed penalty and basis for that amount;

(D) The place to which, and the manner in which, payment is to be made;

(E) A statement that the party may decline the Notice of Violation and that if the Notice of Violation is declined within 30 days of the date shown on the Notice of Violation, the party has the right to a hearing, if requested within 30 days of the date shown on the Notice of Violation, prior to a final assessment of a penalty by a Hearing Officer; and

(F) A statement that failure to either pay the proposed penalty or to decline the Notice of Violation and request a hearing within 30 days of the date shown on the Notice of Violation will result in a finding of violation by default and that NHTSA will proceed with the civil penalty in the amount proposed on the Notice of Violation without processing the violation under the hearing procedures set forth in this subpart.

(ii) The Notice of Violation may be delivered to the party by—

(A) Mailing to the party (certified mail is not required);

(B) Use of an overnight or express courier service; or

(C) Facsimile transmission or electronic mail (with or without attachments) to the party or an employee of the party.

(iii) At any time after the Notice of Violation is issued, NHTSA and the party may agree to reach a compromise on the payment amount.

(iv) Once a penalty amount is paid in full, a finding of ''resolved with payment'' will be entered into the case file.

(v) If the party agrees to pay the proposed penalty, but has not made payment within 30 days of the date shown on the Notice of Violation, NHTSA will enter a finding of violation by default in the matter and NHTSA will proceed with the civil penalty in the amount proposed on the Notice of Violation without processing the violation under the hearing procedures set forth in this subpart.

(vi) If within 30 days of the date shown on the Notice of Violation a party fails to pay the proposed penalty on the Notice of Violation, and fails to request a hearing, then NHTSA will enter a finding of violation by default in the case file, and will assess the civil penalty in the amount set forth on the Notice of Violation without processing the violation under the hearing procedures set forth in this subpart.

(vii) NHTSA's order assessing the civil penalty following a party's default is a final agency action.

(7) *Hearing Officer.* (i) If a party timely requests a hearing after receiving a Notice of Violation, a Hearing Officer shall hear the case.

(ii) The Hearing Officer will be appointed by the NHTSA Administrator, and is solely responsible for the case referred to him or her. The Hearing Officer shall have no other responsibility, direct or supervisory, for the investigation of cases referred for the assessment of civil penalties. The Hearing Officer shall have no duties related to the light-duty fuel economy or medium- and heavy-duty fuel efficiency programs.

(iii) The Hearing Officer decides each case on the basis of the information before him or her.

(8) *Initiation of action before the Hearing Officer.* (i) After the Hearing Officer receives the case file from the Chief Counsel, the Hearing Officer notifies the party in writing of–

(A) The date, time, and location of the hearing and whether the hearing will be conducted telephonically or at the DOT Headquarters building in Washington, DC;

(B) The right to be represented at all stages of the proceeding by counsel as set forth in paragraph (b)(9) of this section; and

(C) The right to a free copy of all written evidence in the case file.

(ii) On the request of a party, or at the Hearing Officer's direction, multiple proceedings may be consolidated if at any time it appears that such consolidation is necessary or desirable.

(9) *Counsel.* A party has the right to be represented at all stages of the proceeding by counsel. A party electing to be represented by counsel must notify the Hearing Officer of this election in writing, after which point the Hearing Officer will direct all further communications to that counsel. A party represented by counsel bears all of its own attorneys' fees and costs.

(10) *Hearing location and costs.* (i) Unless the party requests a hearing at which the party appears before the Hearing Officer in Washington, DC, the hearing may be held telephonically. In Washington, DC, the hearing is held at the headquarters of the U.S. Department of Transportation.

(ii) The Hearing Officer may transfer a case to another Hearing Officer at a party's request or at the Hearing Officer's direction.

(iii) A party is responsible for all fees and costs (including attorneys' fees and costs, and costs that may be associated with travel or accommodations) associated with attending a hearing.

(11) *Hearing procedures.* (i) There is no right to discovery in any proceedings conducted pursuant to this subpart.

(ii) The material in the case file pertinent to the issues to be determined by the Hearing Officer is presented by the Chief Counsel or his or her designee.

(iii) The Chief Counsel may supplement the case file with information prior to the hearing. A copy of such information will be provided to the party no later than three business days before the hearing.

(iv) At the close of the Chief Counsel's presentation of evidence, the party has the right to examine respond to and rebut material in the case file and other information presented by the Chief Counsel. In the case of witness testimony, both parties have the right of cross-examination.

(v) In receiving evidence, the Hearing Officer is not bound by strict rules of evidence. In evaluating the evidence presented, the Hearing Officer must give due consideration to the reliability and relevance of each item of evidence.

(vi) At the close of the party's presentation of evidence, the Hearing Officer may allow the introduction of rebuttal evidence that may be presented by the Chief Counsel.

(vii) The Hearing Officer may allow the party to respond to any rebuttal evidence submitted.

(viii) After the evidence in the case has been presented, the Chief Counsel and the party may present arguments on the issues in the case. The party may also request an opportunity to submit a written statement for consideration by the Hearing Officer and for further review. If granted, the Hearing Officer shall allow a reasonable time for submission of the statement and shall specify the date by which it must be received. If the statement is not received within the time prescribed, or within the limits of any extension of time granted by the Hearing Officer, it need not be considered by the Hearing Officer.

(ix) A verbatim transcript of the hearing will not normally be prepared. A party may, solely at its own expense, cause a verbatim transcript to be made. If a verbatim transcript is made, the party shall submit two copies to the Hearing Officer not later than 15 days after the hearing. The Hearing Officer shall include such transcript in the record.

(12) *Determination of violations and assessment of civil penalties.* (i) Not later than 30 days following the close of the hearing, the Hearing Officer shall issue a written decision on the Notice of Violation, based on the hearing record. This may be extended by the Hearing officer if the submissions by the Chief Counsel or the party are voluminous. The decision shall address each alleged violation, and may do so collectively. For each alleged violation, the decision shall find a violation or no violation and provide a basis for the finding. The decision shall set forth the basis for the Hearing Officer's assessment of a civil penalty, or decision not to assess a civil penalty. In determining the amount of the civil penalty, the gravity of the violation, the size of the violator's business, the violator's history of compliance with applicable fuel consumption standards, the actual fuel consumption performance related to the applicable standard, the estimated cost to comply with the regulation and applicable standard, the quantity of vehicles or engines not complying, and

the effect of the penalty on the violator's ability to continue in business. The assessment of a civil penalty by the Hearing Officer shall be set forth in an accompanying final order. The Hearing Officer's written final order is a final agency action.

(ii) If the Hearing Officer assesses civil penalties in excess of $1,000,000, the Hearing Officer's decision shall contain a statement advising the party of the right to an administrative appeal to the Administrator within a specified period of time. The party is advised that failure to submit an appeal within the prescribed time will bar its consideration and that failure to appeal on the basis of a particular issue will constitute a waiver of that issue in its appeal before the Administrator.

(iii) The filing of a timely and complete appeal to the Administrator of a Hearing Officer's order assessing a civil penalty shall suspend the operation of the Hearing Officer's penalty, which shall no longer be a final agency action.

(iv) There shall be no administrative appeals of civil penalties assessed by a Hearing Officer of less than $1,000,000.

(13) *Appeals of civil penalties in excess of $1,000,000.* (i) A party may appeal the Hearing Officer's order assessing civil penalties over $1,000,000 to the Administrator within 21 days of the date of the issuance of the Hearing Officer's order.

(ii) The Administrator will review the decision of the Hearing Officer de novo, and may affirm the decision of the hearing officer and assess a civil penalty, or

(iii) The Administrator may—

(A) Modify a civil penalty;

(B) Rescind the Notice of Violation; or

(C) Remand the case back to the Hearing Officer for new or additional proceedings.

(iv) In the absence of a remand, the decision of the Administrator in an appeal is a final agency action.

(14) *Collection of assessed or compromised civil penalties.* (i) Payment of a civil penalty, whether assessed or compromised, shall be made by check, postal money order, or electronic transfer of funds, as provided in instructions by the agency. A payment of civil penalties shall not be considered a request for a hearing.

(ii) The party must remit payment of any assessed civil penalty to NHTSA within 30 days after receipt of the Hearing Officer's order assessing civil penalties, or, in the case of an appeal to the Administrator, within 30 days after receipt of the Administrator's decision on the appeal.

(iii) The party must remit payment of any compromised civil penalty to NHTSA on the date and under such terms and conditions as agreed to by the party and NHTSA. Failure to pay may result in NHTSA entering a finding of violation by default and assessing a civil penalty in the amount proposed in the Notice of Violation without processing the violation under the hearing procedures set forth in this part.

(c) *Changes in corporate ownership and control.* Manufacturers must inform NHTSA of corporate relationship changes to ensure that credit accounts are identified correctly and credits are assigned and allocated properly.

(1) In general, if two manufacturers merge in any way, they must inform NHTSA how they plan to merge their credit accounts. NHTSA will subsequently assess corporate fuel consumption and compliance status of the merged fleet instead of the original separate fleets.

(2) If a manufacturer divides or divests itself of a portion of its automobile manufacturing business, it must inform NHTSA how it plans to divide the manufacturer's credit holdings into two or more accounts. NHTSA will subsequently distribute holdings as directed by the manufacturer, subject to provision for reasonably anticipated compliance obligations.

(3) If a manufacturer is a successor to another manufacturer's business, it must inform NHTSA how it plans to allocate credits and resolve liabilities per 49 CFR part 534.

§ 535.10 How do manufacturers comply with fuel consumption standards?

(a) *Pre-certification process.* (1) Regulated manufacturers determine eligibility to use exemptions or exclusions in accordance with § 535.3.

(2) Manufacturers may seek preliminary approvals as specified in 40 CFR 1036.210 and 40 CFR 1037.210. Manufacturers may request to schedule pre-certification meetings with EPA and NHTSA prior to submitting approval requests for certificates of conformity to address any joint compliance issues and gain informal feedback from the agencies.

(3) The requirements and prohibitions required by EPA in special circumstances in accordance with 40 CFR 1037.601 and 40 CFR part 1068 apply to manufacturers for the purpose of complying with fuel consumption standards. Manufacturers should use good judgment when determining how EPA requirements apply in complying with the NHTSA program. Manufacturers may contact NHTSA and EPA for clarification about how these requirements apply to them.

(4) In circumstances in which EPA provides multiple compliance approaches manufacturers must choose the same compliance path to comply with NHTSA's fuel consumption standards that they choose to comply with EPA's greenhouse gas emission standards.

(5) Manufacturers may not introduce new vehicles into commerce without a certificate of conformity from EPA. Manufacturers must attest to several compliance standards in order to obtain a certificate of conformity. This includes stating comparable fuel consumption results for all required CO_2 emissions rates. Manufacturers not completing these steps do not comply with the NHTSA fuel consumption standards.

(6) Manufacturers apply the fuel consumption standards specified in § 535.5 to vehicles, engines and components that represent production units and components for vehicle and engine families, sub-families and configurations consistent with the EPA specifications in 40 CFR 86.1819, 1036.230, and 1037.230.

(7) Only certain vehicles and engines are allowed to comply differently between the NHTSA and EPA programs as detailed in this section. These vehicles and engines must be identified by manufacturers in the ABT and production reports required in § 535.8.

(b) *Model year compliance.* Manufacturers are required to conduct testing to demonstrate compliance with CO_2 exhaust emissions standards in accordance with EPA's provisions in 40 CFR part 600, subpart B, 40 CFR 1036, subpart F, 40 CFR part 1037, subpart R, and 40 CFR part 1066. Manufacturers determine equivalent fuel consumption performance values for CO_2 results as specified in § 535.6 and demonstrate compliance by comparing equivalent results to the applicable fuel consumption standards in § 535.5.

(c) *End-of-the-year process.* Manufacturers comply with fuel consumption standards after the end of each model year, if—

(1) For heavy-duty pickup trucks and vans, the manufacturer's fleet average performance, as determined in § 535.6, is less than the fleet average standard; or

(2) For truck tractors, vocational vehicles, engines and box trailers the manufacturer's fuel consumption performance for each vehicle or engine family (or sub-family), as determined in § 535.6, is lower than the applicable regulatory subcategory standards in § 535.5.

(3) For non-box and non-aero trailers, a manufacturer is considered in compliance with fuel consumption standards if all trailers meet the specified standards in § 535.5(e)(1)(i).

(4) NHTSA will use the EPA final verified values as specified in 40 CFR 86.1819, 40 CFR 1036.755 and 1037.755 for making final determinations on whether vehicles and engines comply with fuel consumption standards.

(5) A manufacturer fails to comply with fuel consumption standards if its final reports are not provided in accordance with § 535.7 and 40 CFR 86.1865, 1036.730, and 1037.730. Manufacturers not providing complete or accurate final reports by the required deadlines do not comply with fuel consumption standards. A manufacturer that is unable to provide any emissions results along with comparable fuel consumption values must obtain permission for EPA to exclude the results prior to the deadline for submitting final reports.

(6) A manufacturer that would otherwise fail to directly comply with fuel consumption standards as described in paragraphs (c)(1) through (3) of this section may use one or more of the credit flexibilities provided under the NHTSA averaging, banking and trading program, as specified in § 535.7, but must offset all credit deficits in its averaging sets to achieve compliance.

(7) A manufacturer failing to comply with the provisions specified in this part may be liable to pay civil penalties in accordance with § 535.9.

(8) A manufacturer may also be liable to pay civil penalties if found by EPA or NHTSA to have provided false information as identified through NHTSA or EPA enforcement audits or new vehicle verification testing as specified in § 535.9 and 40 CFR parts 86, 1036, and 1037.

PART 537—AUTOMOTIVE FUEL ECONOMY REPORTS

■ 290. Revise the authority citation for part 537 to read as follows:

Authority: 49 U.S.C. 32907; delegation of authority at 49 CFR 1.95.

■ 291. Revise § 537.5 to read as follows:

§ 537.5 General requirements for reports.

(a) For each current model year, each manufacturer shall submit a pre-model year report, a mid-model year report, and, as required by § 537.8, supplementary reports.

(b)(1) The pre-model year report required by this part for each current model year must be submitted during the month of December (*e.g.,* the pre-model year report for the 1983 model year must be submitted during December, 1982).

(2) The mid-model year report required by this part for each current model year must be submitted during the month of July (*e.g.,* the mid-model year report for the 1983 model year must be submitted during July 1983).

(3) Each supplementary report must be submitted in accordance with § 537.8(c).

(c) Each report required by this part must–

(1) Identify the report as a pre-model year report, mid-model year report, or supplementary report as appropriate;

(2) Identify the manufacturer submitting the report;

(3) State the full name, title, and address of the official responsible for preparing the report;

(4) Be submitted through an electronic portal identified by NHTSA (*i.e.* the Environmental Protection Agency VERYIFY database) or through the NHTSA CAFE database.

(5) Identify the current model year;

(6) Be written in the English language; and

(7)(i) Specify any part of the information or data in the report that the manufacturer believes should be withheld from public disclosure as trade secret or other confidential business information.

(ii) With respect to each item of information or data requested by the manufacturer to be withheld under 5 U.S.C. 552(b)(4) and 15 U.S.C. 2005(d)(1), the manufacturer shall–

(A) Show that the item is within the scope of sections 552(b)(4) and 2005(d)(1);

(B) Show that disclosure of the item would result in significant competitive damage;

(C) Specify the period during which the item must be withheld to avoid that damage; and

(D) Show that earlier disclosure would result in that damage.

(d) Each report required by this part must be based upon all information and data available to the manufacturer 30 days before the report is submitted to the Administrator.

PART 538—MANUFACTURING INCENTIVES FOR ALTERNATIVE FUEL VEHICLES

■ 292. Revise the authority citation for part 538 to read as follows:

Authority: 49 U.S.C. 32901, 32905, and 32906; delegation of authority at 49 CFR 1.95.

■ 293. Revise § 538.5 to read as follows:

§ 538.5 Minimum driving range.

(a) The minimum driving range that a passenger automobile must have in order to be treated as a dual fueled automobile pursuant to 49 U.S.C. 32901(c) is 200 miles when operating on its nominal useable fuel tank capacity of the alternative fuel, except when the alternative fuel is electricity or compressed natural gas. Beginning model year 2016, a natural gas passenger automobile must have a minimum driving range of 150 miles when operating on its nominal useable fuel tank capacity of the alternative fuel to be treated as a dual fueled automobile, pursuant to 49 U.S.C. 32901(c)(2).

(b) The minimum driving range that a passenger automobile using electricity as an alternative fuel must have in order to be treated as a dual fueled automobile pursuant to 49 U.S.C. 32901(c) is 7.5 miles on its nominal storage capacity of electricity when operated on the EPA urban test cycle and 10.2 miles on its nominal storage capacity of electricity when operated on the EPA highway test cycle.

Dated: June 19, 2015.

Anthony R. Foxx,

Secretary, Department of Transportation

Dated: June 19, 2015.

Gina McCarthy,

Administrator, Environmental Protection Agency.

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