74152 Federal Register / Vol. 75, No. 229 / Tuesday, November 30, 2010 / Proposed Rules

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 85, 86, 1036, 1037, 1065, 1066, and 1068

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Parts 523, 534, and 535

[EPA–HQ–OAR–2010–0162; NHTSA–2010–0079; FRL–9219–4]

RIN 2060–AP61; RIN 2127–AK74

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

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

ACTION: Proposed rules.

SUMMARY: EPA and NHTSA, on behalf of the Department of Transportation, are each proposing rules to establish a comprehensive Heavy-Duty National Program that will reduce greenhouse gas emissions and increase fuel efficiency for on-road heavy-duty vehicles, responding to the President's directive on May 21, 2010, to take coordinated steps to produce a new generation of clean vehicles. NHTSA's proposed fuel consumption standards and EPA's proposed carbon dioxide (CO_2) emissions standards would be tailored to each of three regulatory categories of heavy-duty vehicles: Combination Tractors; Heavy-Duty Pickup Trucks and Vans; and Vocational Vehicles, as well as gasoline and diesel heavy-duty engines. EPA's proposed hydrofluorocarbon emissions standards would apply to air conditioning systems in tractors, pickup trucks, and vans, and EPA's proposed nitrous oxide (N_2O) and methane (CH_4) emissions standards would apply to all heavy-duty engines, pickup trucks, and vans. EPA is also requesting comment on possible alternative CO_2-equivalent approaches for model year 2012–14 light-duty vehicles.

EPA's proposed greenhouse gas emission standards under the Clean Air Act would begin with model year 2014. NHTSA's proposed fuel consumption standards under the Energy Independence and Security Act of 2007 would be voluntary in model years 2014 and 2015, becoming mandatory with model year 2016 for most regulatory categories. Commercial trailers would not be regulated in this phase of the Heavy-Duty National Program, although there is a discussion of the possibility of future action for trailers.

DATES: *Comments:* Comments on all aspects of this proposal must be received on or before January 31, 2011. Under the Paperwork Reduction Act, comments on the information collection provisions must be received by the Office of Management and Budget on or before December 30, 2010. *See* the **SUPPLEMENTARY INFORMATION** section on "Public Participation" for more information about written comments.

Public Hearings: NHTSA and EPA will jointly hold two public hearings on the following dates: November 15, 2010 in Chicago, IL; and November 18, 2010 in Cambridge, MA, as announced at 75 FR 67059, November 1, 2010. The hearing in Chicago will start at 11 a.m. local time and continue until 5 p.m. or until everyone has had a chance to speak. The hearing in Cambridge will begin at 10 a.m. and continue until 5 p.m. or until everyone has had a chance to speak. *See* "How Do I Participate in the Public Hearings?" below at B. (7) under the **SUPPLEMENTARY INFORMATION** section on "Public Participation" for more information about the public hearings.

ADDRESSES: Submit your comments, identified by Docket ID No. NHTSA–2010–0079 and/or EPA–HQ–OAR–2010–0162, by one of the following methods:

- *http://www.regulations.gov:* Follow the on-line instructions for submitting comments.
- *E-mail: a-and-r-docket@epa.gov.*
- *Fax: NHTSA:* (202) 493–2251; *EPA:* (202) 566–9744.
- *Mail:*

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.

EPA: Air Docket, Environmental Protection Agency, EPA Docket Center, Mailcode: 6102T, 1200 Pennsylvania Ave., NW., Washington, DC 20460. In addition, please mail a copy of your comments on the information collection provisions to the Office of Information and Regulatory Affairs, Office of Management and Budget (OMB), Attn: Desk Officer for EPA, 725 17th St., NW., Washington, DC 20503.

- *Hand Delivery:*

NHTSA: West Building, Ground Floor, Rm. W12–140, 1200 New Jersey Avenue, SE., Washington, DC 20590, between 9 a.m. and 5 p.m. Eastern Time, Monday through Friday, except Federal Holidays.

EPA: EPA Docket Center, (Air Docket), U.S. Environmental Protection Agency, EPA West Building, 1301 Constitution Ave., NW., Room: 3334, Mail Code 2822T, Washington, DC. Such deliveries are only accepted during the Docket's normal hours of operation, and special arrangements should be made for deliveries of boxed information.

Instructions: Direct your comments to Docket ID No. NHTSA–2010–0079 and/or EPA–HQ–OAR–2010–0162. *See* the **SUPPLEMENTARY INFORMATION** section on "Public Participation" for additional instructions on submitting written comments.

Docket: All documents in the docket are listed in the *http://www.regulations.gov* index. 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, will be publicly available only in hard copy in EPA's docket, but may be available electronically in NHTSA's docket at regulations.gov. Publicly available docket materials are available either electronically in *http://www.regulations.gov* or in hard copy at the following locations:

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 Docket Management Facility is open between 9 a.m. and 5 p.m. Eastern Time, Monday through Friday, except Federal holidays.

EPA: EPA Docket Center, EPA/DC, EPA West, Room 3334, 1301 Constitution Ave., NW., 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 Air Docket is (202) 566–1742.

FOR FURTHER INFORMATION CONTACT: *NHTSA:* Rebecca Yoon, Office of Chief Counsel, National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE., Washington, DC 20590. Telephone: (202) 366–2992. *EPA:* Lauren Steele, Office of Transportation and Air Quality, Assessment and Standards Division (ASD), Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; telephone number: (734) 214–4788; fax number: (734) 214–4816; e-mail address: *steele.lauren@epa.gov,* or Assessment and Standards Division Hotline; telephone number; (734) 214–4636; e-mail *asdinfo@epa.gov.*

SUPPLEMENTARY INFORMATION:

Does this action apply to me?

This 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, school and transit buses, vocational vehicles such as utility service trucks, as well as ¾-ton and 1-ton pickup trucks and vans.[1] The heavy-duty category incorporates all motor vehicles with a gross vehicle weight rating of 8,500 pounds 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 2012–2016 vehicles. This action also includes a discussion of the possible future regulation of commercial trailers and is requesting comment on possible alternative CO_2-equivalent approaches for model year 2012–14 light-duty vehicles. Potentially affected categories and entities include the following:

Category	NAICS Code[a]	Examples of Potentially Affected Entities
Industry	336111 336112 336120	Motor Vehicle Manufacturers, Engine and Truck Manufacturers
Industry	541514 811112 811198	Commercial Importers of Vehicles and Vehicle Components
Industry	336111 336112 422720 454312 541514 541690 811198	Alternative Fuel Vehicle Converters
Industry	336212	Truck Trailer Manufacturers[b]

Note:
[a] North American Industry Classification System (NAICS)
[b] This category is included for purposes of advance notice of possible future rulemaking action

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this proposal. This table lists the types of entities that the agencies are now aware could potentially be regulated by this action. Other types of entities not listed in the table could also be regulated. To determine whether your activities may be regulated by this action, you should carefully examine the applicability criteria in 40 CFR parts 1036 and 1037, 49 CFR parts 523, 534, and 535, and 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

NHTSA and EPA request comment on all aspects of these joint proposed rules. 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 aspects of the program common to both EPA and NHTSA. For the convenience of all parties, comments submitted to the EPA docket (whether hard copy or electronic) will be considered comments submitted to the NHTSA docket, and vice versa. An exception is that comments submitted to the NHTSA docket on the Draft Environmental Impact Statement 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. 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 the EPA or NHTSA docket are described below.

[1] For purposes of NHTSA's fuel consumption regulations, non-commercial recreational vehicles will not be covered, even if they would otherwise fall under these categories. *See* 49 U.S.C. 32901(a)(7).

NHTSA: Your comments must be written and in English. To ensure that your comments are correctly filed in the Docket, please include the Docket I.D No. NHTSA–2010–0079 in your comments. By regulation, your comments must not be more than 15 pages long (49 CFR 553.21). 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. There is no limit on the lenght 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 agencies, it must meet the information quality standards set forth in the OMB and Department of Transportation (DOT) Data Quality Act quidelines. 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 access at *http://regs.dot.gov*.

EPA: Direct your comments to Docket ID No EPA–HQ–OAR–2010–0162. EPA's policy is that all comments received will be included in the public docket without change and may be made available online at *http://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 *http://www.regulations.gov* or e-mail. The *http://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 e-mail comment directly to EPA without going through *http://www.regulations.gov* your e-mail 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.*

(2) Tips for Preparing Your Comments

When submitting comments, remember to:

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

• Follow directions—The agencies may ask you to respond to specific questions or organize comments by referencing a part or section number from the Code of Federal Regulations.

• 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 CBI submitted to one of the agencies will also be available to the other agency.[3] 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.

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 CBI, to the Chief Counsel, NHTSA, at the address given above under **FOR FURTHER INFORMATION CONTACT**. When you send a comment containing CBI, you should include a cover letter setting forth the information specified in our CBI regulation. In addition, you should submit a copy from which you have deleted the claimed CBI to the Docket by one of the methods set forth above.

EPA: Do not submit CBI to EPA through *http://www.regulations.gov* or e-mail. Clearly mark the part or all of the information that you claim to be CBI. For CBI 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. 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.

(5) Will the agencies consider late comments?

NHTSA and EPA will consider all comments received before the close of business on the comment closing date indicated above under **DATES**. To the extent practicable, we will also consider comments received after that date. If interested persons believe that any new information the agency places in the docket affects their comments, they may submit comments after the closing date concerning how the agency should consider that information for the final rules. However, the agencies' ability to consider any such late comments in this rulemaking will be limited due to the time frame for issuing the final rules.

If a comment is received too late for us to practicably consider in developing the final rules, we will consider that comment as an informal suggestion for future rulemaking action.

[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] This statement constitutes notice to commenters pursuant to 40 CFR 2.209(c) that EPA will share confidential business information received with NHTSA unless commenters expressly specify that they wish to submit their CBI only to EPA and not to both agencies.

How can I read the comments submitted by other people?

You may read the materials placed in the dockets 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 NHTSA Docket Management Facility or the EPA Docket Center by going to the street addresses given above under **ADDRESSES.**

How do I participate in the public hearings?

EPA and NHTSA will jointly host two public hearings. The November 15 hearing will be held at the Millennium Knickerbocker Hotel Chicago, 163 East Walton Place (at N. Michigan Ave.), Chicago, Illinois 60611. The November 18, 2010 hearing will be held at the Hyatt Regency Cambridge, 575 Memorial Drive, Cambridge, Massachusetts 02139–4896. If you would like to present oral testimony at a public hearing, we ask that you notify both the NHTSA and EPA contact persons listed under **FOR FURTHER INFORMATION CONTACT** at least ten days before the hearing. Once the agencies learn how many people have registered to speak at the public hearings, we will allocate an appropriate amount of time to each participant, allowing time for necessary breaks. For planning purposes, each speaker should anticipate speaking for approximately ten minutes, although we may need to shorten that time if there is a large turnout. We request that you bring three copies of your statement or other material for the agencies' panels. To accommodate as many speakers as possible, we prefer that speakers not use technological aids (e.g., audio-visuals, computer slideshows). In addition, we will reserve a block of time for anyone else in the audience who wants to give testimony.

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

C. Additional Information About This Rulemaking

EPA's Advance Notice of Proposed Rulemaking for regulating greenhouse gases under the CAA (see 73 FR 44353, July 30, 2008) included a discussion of possible rulemaking paths for the heavy-duty transportation sector. This notice of proposed rulemaking relies in part on information that was obtained from that notice, which can be found in Public Docket EPA–HQ–OAR–2008–0318. That docket is incorporated into the docket for this action, EPA–HQ–OAR–2010–0162.

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I. Overview

A. Introduction

EPA and NHTSA ("the agencies") are announcing a first-ever program to reduce greenhouse gas (GHG) emissions and improve fuel efficiency in the heavy-duty highway vehicle sector. This broad sector—ranging from large pickups to sleeper-cab tractors—together represent the second largest contributor to oil consumption and GHG emissions, after light-duty passenger cars and trucks.

In a recent memorandum to the Administrators of EPA and NHTSA (and the Secretaries of Transportation and

Energy), the President stated that "America has the opportunity to lead the world in the development of a new generation of clean cars and trucks through innovative technologies and manufacturing that will spur economic growth and create high-quality domestic jobs, enhance our energy security, and improve our environment."[4] Earlier this year, EPA and NHTSA established for the first time a national program to sharply reduce GHG emissions and fuel consumption from passenger cars and light trucks. Now, each agency is proposing rules that together would create a strong and comprehensive Heavy-Duty National Program ("HD National Program") designed to address the urgent and closely intertwined challenges of dependence on oil, energy security, and global climate change. At the same time, the proposed program would enhance American competitiveness and job creation, benefit consumers and businesses by reducing costs for transporting goods, and spur growth in the clean energy sector.

A number of major HD truck and engine manufacturers representing the vast majority of this industry, and the California Air Resources Board (California ARB), sent letters to EPA and NHTSA supporting a HD National Program based on a common set of principles. In the letters, the stakeholders commit to working with the agencies and with other stakeholders toward a program consistent with common principles, including:

- Increased use of existing technologies to achieve significant GHG emissions and fuel consumption reductions;
- A program that starts in 2014 and is fully phased in by 2018;
- A program that works towards harmonization of methods for determining a vehicle's GHG and fuel efficiency, recognizing the global nature of the issues and the industry;
- Standards that recognize the commercial needs of the trucking industry; and
- Incentives leading to the early introduction of advanced technologies.

The proposed HD National Program builds on many years of heavy-duty engine and vehicle technology development to achieve what the agencies believe would be the greatest degree of GHG emission and fuel consumption reduction appropriate, feasible, and cost-effective for the model years in question. Still, by proposing to take aggressive steps that are reasonably possible now, based on the technological opportunities and pathways that present themselves during these model years, the agencies and industry will also continue learning about emerging opportunities for this complex sector to further reduce GHG emissions and fuel consumption. For example, NHTSA and EPA have stopped short of proposing fuel consumption and GHG emissions standards for trucks based on use of hybrid powertrain technology. Similarly, we expect that the agencies will participate in efforts to improve our ability to accurately characterize the actual in-use fuel consumption and emissions of this complex sector. As such opportunities emerge in the coming years, we expect that we will propose a second phase of provisions in the future to reinforce these developments and maximize the achieved reductions in GHG emissions and fuel consumption reduction for the mid- and longer-term time frame.

In the May 21 memorandum, the President requested the Administrators of EPA and NHTSA to "immediately begin work on a joint rulemaking under the Clean Air Act (CAA) and the Energy Independence and Security Act of 2007 (EISA) to establish fuel efficiency and greenhouse gas emissions standards for commercial medium- and heavy-duty vehicles beginning with the 2014 model year (MY), with the aim of issuing a final rule by July 30, 2011." This proposed rulemaking is consistent with this Presidential Memorandum, with each agency proposing rules under its respective authority that together comprise a coordinated and comprehensive HD National Program.

Heavy-duty vehicles move much of the nation's freight and carry out numerous other tasks, including utility work, concrete delivery, fire response, refuse collection, and many more. Heavy-duty vehicles are primarily powered by diesel engines, although about 37 percent of these vehicles are powered by gasoline engines. Heavy-duty trucks[5] have always been an important part of the goods movement infrastructure in this country and have experienced significant growth over the last decade related to increased imports and exports of finished goods and increased shipping of finished goods to homes through Internet purchases.

The heavy-duty sector is extremely diverse in several respects, including types of manufacturing companies involved, the range of sizes of trucks and engines they produce, the types of work the trucks are designed to perform, and the regulatory history of different subcategories of vehicles and engines. The current heavy-duty fleet encompasses vehicles from the "18-wheeler" combination tractors one sees on the highway to school and transit buses, to vocational vehicles such as utility service trucks, as well as the largest pickup trucks and vans.

For purposes of this preamble, the term "heavy-duty" or "HD" is used to apply to all highway vehicles and engines that are not within the range of light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles (MDPV) covered by the GHG and Corporate Average Fuel Economy (CAFE) standards issued for MY 2012–2016.[6] It also does not include motorcycles. Thus, in this notice, unless specified otherwise, the heavy-duty category incorporates all vehicles with a gross vehicle weight rating above 8,500 pounds, and the engines that power them, except for MDPVs.[7] We note that the Energy Independence and Security Act of 2007 requires NHTSA to set standards for "commercial medium- and heavy-duty on-highway vehicles and work trucks."[8] NHTSA interprets this to include all segments of the heavy-duty category described above, except for recreational vehicles, such as motor homes, since recreational vehicles are not commercial.

Setting GHG emissions standards for the heavy-duty sector will help to address climate change, which is widely viewed as a significant long-term threat to the global environment. As summarized in the Technical Support Document for EPA's Endangerment and Cause or Contribute Findings under Section 202(a) of the Clean Air Act, anthropogenic emissions of GHGs are very likely (a 90 to 99 percent probability) the cause of most of the

[4] Improving Energy Security, American Competitiveness and Job Creation, and Environmental Protection Through a Transformation of Our Nation's Fleet of Cars And Trucks," Issued May 21, 2010, published at 75 FR 29399, May 26, 2010.

[5] In this rulemaking, EPA and NHTSA use the term "truck" in a general way, referring to all categories of regulated heavy-duty highway vehicles (including buses). As such, the term is generally interchangeable with "heavy-duty vehicle."

[6] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule 75 FR 25323,(May 7, 2010).

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

[8] 49 U.S.C. 32902(k)(2). "Commercial medium- and heavy-duty on-highway vehicles" are defined as on-highway vehicles with a gross vehicle weight rating of 10,000 pounds or more, while "work trucks" are defined as vehicles rated between 8,500 and 10,000 pounds gross vehicle weight that are not MDPVs. *See* 49 U.S.C. 32901(a)(7) and (a)(19).

observed global warming over the last 50 years.[9] The primary GHGs of concern are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Mobile sources emitted 31 percent of all U.S. GHGs in 2007 (transportation sources, which do not include certain off-highway sources, account for 28 percent) and have been the fastest-growing source of U.S. GHGs since 1990.[10] Mobile sources addressed in the recent endangerment and contribution findings under CAA section 202(a)—light-duty vehicles, heavy-duty trucks, buses, and motorcycles—accounted for 23 percent of all U.S. GHG emissions in 2007.[11] Heavy-duty vehicles emit CO_2, CH_4, N_2O, and HFCs and are responsible for nearly 19 percent of all mobile source GHGs (nearly 6% of all U.S. GHGs) and about 25 percent of section 202(a) mobile source GHGs. For heavy-duty vehicles in 2007, CO_2 emissions represented more than 99 percent of all GHG emissions (including HFCs).[12]

Setting fuel consumption standards for the heavy-duty sector, pursuant to NHTSA's EISA authority, will also improve our energy security by reducing our dependence on foreign oil, which has been a national objective since the first oil price shocks in the 1970s. Net petroleum imports now account for approximately 60 percent of U.S. petroleum consumption. World crude oil production is highly concentrated, exacerbating the risks of supply disruptions and price shocks. Tight global oil markets led to prices over $100 per barrel in 2008, with gasoline reaching as high as $4 per gallon in many parts of the United States, causing financial hardship for many families and businesses. The export of U.S. assets for oil imports continues to be an important component of the historically unprecedented U.S. trade deficits. Transportation accounts for about 72 percent of U.S. petroleum consumption. Heavy-duty vehicles account for about 17 percent of transportation oil use, which means that they alone account for about 12 percent of all U.S. oil consumption.[13]

In developing this joint proposal, the agencies have worked with a large and diverse group of stakeholders representing truck and engine manufacturers, trucking fleets, environmental organizations, and States including the State of California.[14] While our discussions covered a wide range of issues and viewpoints, one widespread recommendation was that the two agencies should develop a common Federal program with consistent standards of performance regarding fuel consumption and GHG emissions. The HD National Program we are proposing in this notice is consistent with that goal. Further it is our expectation based on our ongoing work with the State of California that the California ARB will be able to adopt regulations equivalent in practice to those of this HD National Program, just as it has done for past EPA regulation of heavy-duty trucks and engines. NHTSA and EPA are committed to continuing to work with California ARB throughout this rulemaking process to help ensure our final rules can lead to that outcome.

In light of the industry's diversity, and consistent with the recommendations of the National Academy of Sciences (NAS) as discussed further below, the agencies are proposing a HD National Program that recognizes the different sizes and work requirements of this wide range of heavy-duty vehicles and their engines. NHTSA's proposed fuel consumption standards and EPA's proposed GHG standards would apply to manufacturers of the following types of heavy-duty vehicles and their engines; the proposed provisions for each of these are described in more detail below in this section:

- Heavy-Duty Pickup Trucks and Vans.
- Combination Tractors.
- Vocational Vehicles.

As in the recent light-duty vehicle rule establishing CAFE and GHG standards for MYs 2012–2016 light-duty vehicles, EPA's and NHTSA's proposed standards for the heavy-duty sector are largely harmonized with one another due to the close and direct relationship between improving the fuel efficiency of these vehicles and reducing their CO_2 tailpipe emissions. For all vehicles that consume carbon-based fuels, the amount of CO_2 emissions is essentially constant per gallon for a given type of fuel that is consumed. The more efficient a heavy-duty truck is in completing its work, the lower its environmental impact will be, because the less fuel consumed to move cargo a given distance, the less CO_2 emitted into the air. The technologies available for improving fuel efficiency, and therefore for reducing both CO_2 emissions and fuel consumption, are one and the same.[15] Because of this close technical relationship, NHTSA and EPA have been able to rely on jointly-developed assumptions, analyses, and analytical conclusions to support the standards and other provisions that NHTSA and EPA are proposing under our separate legal authorities.

The timelines for the implementation of the proposed NHTSA and EPA standards are also closely coordinated. EPA's proposed GHG emission standards would begin in model year 2014. In order to provide for the four full model years of regulatory lead time required by EISA, as discussed in Section I.B.(5) below, NHTSA's proposed fuel consumption standards would be voluntary in model years 2014 and 2015, becoming mandatory in model year 2016, except for diesel engine standards which would be voluntary in model years 2014, 2015 and 2016, becoming mandatory in model year 2017. Both agencies are also allowing early compliance in model year 2013. A detailed discussion of how the proposed standards are consistent with each agency's respective statutory requirements and authorities is found later in this notice.

Neither EPA nor NHTSA is proposing standards at this time for GHG emissions or fuel consumption, respectively, for heavy-duty commercial trailers or for vehicles or engines manufactured by small businesses. However, the agencies are considering proposing such standards in a future rulemaking, and request comment on such an action later in this preamble.

B. Building Blocks of the Heavy-Duty National Program

The standards that are being proposed in this notice represent the first time

[9] U.S. EPA. (2009). "Technical Support Document for Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act" Washington, DC, available at Docket: EPA–HQ–OAR–2009–0171–11645, and at *http://epa.gov/climatechange/endangerment.html.*

[10] U.S. Environmental Protection Agency. 2009. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007. EPA 430–R–09–004. Available at *http://epa.gov/climatechange/emissions/downloads09/GHG2007entire_report-508.pdf* .

[11] *See* Endangerment TSD, Note 9, above, at pp. 180–194.

[12] U.S. Environmental Protection Agency. 2009. Inventory of U.S. Greenhouse Gas Emissions and Sinks: *See* Note 10, above.

[13] In 2009 Source: EIA Annual Energy Outlook 2010 released May 11, 2010.

[14] Pursuant to DOT Order 2100.2, NHTSA will place a memorandum recording those meetings that it attended and documents submitted by stakeholders which formed a basis for this proposal and which can be made publicly available in its docket for this rulemaking. DOT Order 2100.2 is available at *http://www.reg-group.com/library/DOT2100-2.PDF.*

[15] However, as discussed below, in addition to addressing CO_2, the EPA's proposed standards also include provisions to address other GHGs (nitrous oxide, methane, and air conditioning refrigerant emissions), as required by the Endangerment Finding under the CAA. *See* Section II.

that NHTSA and EPA would regulate the heavy-duty sector for fuel consumption and GHG emissions, respectively. The proposed HD National Program is rooted in EPA's prior regulatory history, the SmartWay® Transport Partnership program, and extensive technical and engineering analyses done at the Federal level. This section summarizes some of the most important of these precursors and foundations for this HD National Program.

(1) EPA's Traditional 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 18 years, these programs have primarily addressed emissions of particulate matter (PM) and the primary ozone precursors, hydrocarbons (HC) and oxides of nitrogen (NO_X). These programs have successfully achieved significant and cost-effective reductions in emissions and associated health and welfare benefits to the nation. They have been structured in ways that account for the varying circumstances of the engine and truck industries. As required by the CAA, the emission standards implemented by these programs include standards that apply at the time that the vehicle or engine is sold as well as standards that apply in actual use. As a result of these programs, new vehicles meeting current emission standards will emit 98% less NO_X and 99% less PM than new trucks 20 years ago. The resulting emission reductions provide significant public health and welfare benefits. The most recent EPA regulations which were fully phased-in in 2010 are projected to provide greater than $70 billion in health and welfare benefits annually in 2030 alone (66 FR 5002, January 18, 2001).

EPA's overall program goal has always been to achieve emissions reductions from the complete vehicles that operate on our highways. The agency has often accomplished this goal for many heavy-duty truck categories through the regulation of 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 routinely use 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. The agencies discuss below how the proposed program incorporates the existing engine-based approach used for criteria emissions regulations, as well as new vehicle-based approaches.

(2) NHTSA's Responsibilities To Regulate Heavy-Duty Fuel Efficiency Under EISA

With the passage of the EISA in December 2007, Congress laid out a framework developing the first fuel efficiency regulations for HD vehicles. As codified at 49 U.S.C. 32902(k), EISA requires NHTSA to develop a regulatory system for the fuel economy of commercial medium-duty and heavy-duty on-highway vehicles and work trucks in three steps: A study by NAS, a study by NHTSA, and a rulemaking to develop the regulations themselves.[16]

Specifically, section 102 of EISA, codified at 49 U.S.C. 32902(k)(2), states that not later than two years after completion of the NHTSA study, DOT (by delegation, NHTSA), in consultation with the Department of Energy (DOE) and EPA, shall develop a regulation to implement a "commercial medium-duty and heavy-duty on-highway vehicle and work truck fuel efficiency improvement program designed to achieve the maximum feasible improvement." NHTSA interprets the timing requirements as permitting a regulation to be developed earlier, rather than as requiring the agency to wait a specified period of time.

Congress specified that as part of the "HD fuel efficiency improvement program designed to achieve the maximum feasible improvement," NHTSA must adopt and implement:

- Appropriate test methods;
- Measurement metrics;
- Fuel economy standards;[17] and
- Compliance and enforcement protocols.

Congress emphasized that the test methods, measurement metrics, standards, and compliance and enforcement protocols must all be *appropriate, cost-effective,* and *technologically feasible* for commercial medium-duty and heavy-duty on-highway vehicles and work trucks. NHTSA notes that these criteria are different from the "four factors" of 49 U.S.C. 32902(f)[18] that have long governed NHTSA's setting of fuel economy standards for passenger cars and light trucks, although many of the same factors are considered under each of these provisions.

Congress also stated that NHTSA may set separate standards for different classes of HD vehicles, which the agency interprets broadly to allow regulation of HD engines in addition to HD vehicles, and provided requirements new to 49 U.S.C. 32902 in terms of timing of regulations, stating that the standards adopted as a result of the agency's rulemaking shall provide not less than four full model years of regulatory lead time, and three full model years of regulatory stability.

(3) National Academy of Sciences Report on Heavy-Duty Technology

As mandated by Congress in EISA, the National Research Council (NRC) under NAS recently issued a report to NHTSA and to Congress evaluating medium-duty and heavy-duty truck fuel efficiency improvement opportunities, titled "Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles."[19] This study covers the same universe of heavy-duty vehicles that is the focus of this proposed rulemaking—all highway vehicles that are not light-duty, MDPVs, or motorcycles. The agencies have carefully evaluated the research supporting this report and its recommendations and have incorporated them to the extent practicable in the development of this rulemaking. NHTSA's and EPA's detailed assessments of each of the relevant recommendations of the NAS

[16] The NAS study is described below, and the NHTSA study accompanies this NPRM.

[17] In the context of 49 U.S.C. 32902(k), NHTSA interprets "fuel economy standards" as referring not specifically to miles per gallon, as in the light-duty vehicle context, but instead more broadly to account as accurately as possible for MD/HD fuel *efficiency.* While it is a metric that NHTSA considered for setting MD/HD fuel efficiency standards, the agency recognizes that miles per gallon may not be an appropriate metric given the work that MD/HD vehicles are manufactured to do. NHTSA is thus proposing alternative metrics as discussed further below.

[18] 49 U.S.C. 32902(f) states that "When deciding maximum feasible average fuel economy under this section, [NHTSA] shall consider technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy."

[19] 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* (last accessed September 10, 2010).

report are discussed in Section X of this preamble and in the NHTSA HD study accompanying this notice of proposed rulemaking (NPRM).

(4) The Recent NHTSA and EPA Light-Duty National GHG Program

On April 1, 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. The agencies have used the light-duty National Program as a model for this proposed HD National Program in many respects. This is most apparent in the case of heavy-duty pickups and vans, which are very 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). For these vehicles, there are close parallels to the light-duty program in how the agencies have developed our respective proposed standards and compliance structures, although in this proposal each agency proposes 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. Most notably, as with the light-duty program, manufacturers will be able to design and build to meet a closely coordinated Federal program, and avoid unnecessarily duplicative testing and compliance burdens.

(5) EPA's SmartWay Program

EPA's voluntary SmartWay Transport Partnership program encourages shipping and trucking companies to take actions that reduce fuel consumption and CO_2 by working with the shipping community and the freight sector to identify low carbon strategies and technologies, and by providing technical information, financial incentives, and partner recognition to accelerate the adoption of these strategies. Through the SmartWay program, EPA has worked closely with truck manufacturers and truck fleets to develop test 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. Over the last six years, EPA has developed hands-on experience testing the largest heavy-duty trucks and evaluating improvements in tire and vehicle aerodynamic performance. In 2010, according to vehicle manufacturers, approximately five percent of new combination heavy-duty trucks will meet the SmartWay performance criteria demonstrating that they represent the pinnacle of current heavy-duty truck reductions in fuel consumption.

In developing this HD National Program, the agencies have drawn from the SmartWay experience, as discussed in detail both in Sections II and III below (*e.g.,* developing test procedures to evaluate trucks and truck components) but also in the draft RIA (estimating performance levels from the application of the best available technologies identified in the SmartWay program). These technologies provide part of the basis for the GHG emission and fuel consumption standards proposed in this rulemaking for certain types of new heavy-duty Class 7 and 8 combination tractors.

In addition to identifying technologies, the SmartWay program includes operational approaches that truck fleet owners as well as individual drivers and their freight customers can incorporate, that the NHTSA and EPA believe will complement the proposed standards. These include such approaches as improved logistics and driver training, as discussed in the draft RIA. This approach is consistent with the one of the three alternative approaches that the NAS recommended be considered. The three approaches were raising fuel taxes, liberalizing truck size and weight restrictions, and encouraging incentives to disseminate information to inform truck drivers about the relationship between driving behavior and fuel savings. Taxes and truck size and weight limits are mandated by public law; as such, these options are outside EPA's and NHTSA's authority to implement. However, complementary operational measures like driver training, which SmartWay does promote, can complement the proposed standards and also provide benefits for the existing truck fleet, furthering the public policy objectives of addressing energy security and climate change.

(6.) Canada's Department of the Environment

The Government of Canada's Department of the Environment (Environment Canada) assisted EPA's development of this proposed rulemaking, by conducting emissions testing of heavy-duty vehicles at Environment Canada test facilities to gather data on a range of possible test cycles.

We expect the technical collaboration with Environment Canada to continue as we address issues raised by stakeholders in response to this NPRM, and as we continue to develop details of certain testing and compliance verification procedures. We may also be able to begin to develop a knowledge base enabling improvement upon this regulatory framework for model years beyond 2018 (for example, improvements to the means of demonstrating compliance). We also expect to continue our collaboration with Environment Canada on compliance issues.

C. Summary of the Proposed EPA and NHTSA HD National Program

When EPA first addressed emissions from heavy-duty trucks in the 1980s, it established standards for engines, based on the amount of work performed (grams of pollutant per unit of work, expressed as grams per brake horsepower-hour or g/bhp-hr).[20] This approach recognized the fact that engine characteristics are the dominant determinant of the types of emissions generated, and engine-based technologies (including exhaust aftertreatment systems) need to be the focus for addressing those emissions. Vehicle-based technologies, in contrast, have less influence on overall truck emissions of the pollutants that EPA has regulated in the past. The engine testing approach also recognized the relatively small number of distinct heavy-duty engine designs, as compared to the extremely wide range of truck designs. EPA concluded at that time that any incremental gain in conventional emission control that could be achieved through regulation of the complete vehicle would be small in comparison to the cost of addressing the many variants of complete trucks that make up the heavy-duty sector—smaller and larger vocational vehicles for dozens of purposes, various designs of combination tractors, and many others.

Addressing GHG emissions and fuel consumption from heavy-duty trucks, however, requires a different approach. Reducing GHG emissions and fuel consumption requires increasing the

[20] The term "brake power" refers to engine torque and power as measured at the interface between the engine's output shaft and the dynamometer. This contrasts with "indicated power", which is a calculated value based on the pressure dynamics in the combustion chamber, not including internal losses that occur due to friction and pumping work. Since the measurement procedure inherently measures brake torque and power, the proposed regulations refer simply to g/hp-hr. This is consistent with our other emission control programs, which generally include standards in g/kW-hr.

inherent efficiency of the engine as well as making changes to the vehicles to reduce the amount of work that the engine needs to do per mile traveled. This thus requires a focus on the entire vehicle. For example, in addition to the basic emissions and fuel consumption levels of the engine, the aerodynamics of the vehicle can have a major impact on the amount of work that must be performed to transport freight at common highway speeds. The 2010 NAS Report recognized this need and recommended a complete-vehicle approach to regulation. As described elsewhere in this preamble, the proposed standards that make up the HD National Program aim to address the complete vehicle, to the extent practicable and appropriate under the agencies' respective statutory authorities, through complementary engine and vehicle standards, in order to reduce the complexity of the regulatory system and achieve the greatest gains as soon as possible.

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

The heavy-duty truck sector spans a wide range of vehicles with often unique form and function. A primary indicator of the extreme 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.[21] 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	> 33,001

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.[22] 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 truck 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. Commercial "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 trucks 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, although some travel more and some less. 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 sometimes run without a trailer in between loads, but most of the time they run with one or more trailers that can carry up to 50,000 pounds or more of payload, consuming significant quantities of fuel and producing significant amounts of GHG emissions. The combination tractor-trailers used in combination applications can travel more than 150,000 miles per year.

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 next.

(2) Summary of Proposed EPA GHG Emission Standards and NHTSA Fuel Consumption Standards

As described above, NHTSA and EPA recognize the importance of addressing the entire vehicle in reducing fuel consumption and GHG emissions. At the same time, the agencies understand that the complexity of the industry means that we will need to use different approaches to achieve this goal, depending on the characteristics of each general type of truck. We are therefore proposing to divide the industry into three discrete regulatory categories for purposes of setting our respective standards—combination tractors, heavy-duty pickups and vans, and vocational vehicles—based on the relative degree of homogeneity among trucks within each category. For each regulatory category, the agencies are proposing related but distinct program approaches reflecting the specific challenges that we see for manufacturers in these segments. In the following paragraphs, we discuss EPA's proposed GHG emission standards and NHTSA's proposed fuel consumption standards for the three regulatory categories of heavy-duty vehicles and their engines.

The agencies are proposing test metrics that express fuel consumption and GHG emissions relative to the most important measures of heavy-duty truck utility for each segment, consistent with the recommendation of the 2010 NAS Report that metrics should reflect and account for the work performed by various types of HD vehicles. This approach differs from NHTSA's light-duty program that uses fuel economy as the basis. The NAS committee discussed the difference between fuel economy (a measure of how far a vehicle will go on a gallon of fuel) and fuel consumption (the inverse measure, of how much fuel is consumed in driving a given distance) as potential metrics for MD/HD regulations. The committee concluded that fuel economy would not be a good metric for judging the fuel efficiency of a heavy-duty vehicle, and stated that NHTSA should alternatively consider fuel consumption as the basis for its standards. As a result, for heavy-duty

[21] GVWR describes the maximum load that can be carried by a vehicle, including the weight of the vehicle itself. Heavy-duty vehicles 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.

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

pickup trucks and vans, EPA and NHTSA are proposing standards on a per-mile basis (g/mile for the EPA standards, gallons/100 miles for the NHTSA standards), as explained in Section I.C.(2)(b) below. For heavy-duty trucks, both combination and vocational, the agencies are proposing standards expressed in terms of the key measure of freight movement, tons of payload miles or, more simply, ton-miles. Hence, for EPA the proposed standards are in the form of the mass of emissions from carrying a ton of cargo over a distance of one mile (g/ton-mi)). Similarly, the proposed NHTSA standards are in terms of gallons of fuel consumed over a set distance (one thousand miles), or gal/1,000 ton-mile. Finally, for engines, EPA is proposing standards in the form of grams of emissions per unit of work (g/bhp-hr), the same metric used for the heavy-duty highway engine standards for criteria pollutants today. Similarly, NHTSA is proposing standards for heavy-duty engines in the form of gallons of fuel consumption per 100 units of work (gal/100 bhp-hr).

Section II below discusses the proposed EPA and NHTSA standards in greater detail.

(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 65 percent, due to their large payloads, their high annual miles traveled, and their major role in national freight transport.[23] These vehicles consist of a cab and engine (tractor or combination tractor) and a detachable trailer. In general, reducing GHG emissions and fuel consumption for these vehicles would involve improvements such as aerodynamics and tires and reduction in idle operation, as well as engine-based efficiency improvements.

In general, the heavy-duty combination tractor industry consists of tractor manufacturers (which manufacture the tractor and purchase and install the engine) and trailer manufacturers. These manufacturers are usually separate from each other. 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. The owners of trucks and trailers are often distinct as well. A typical truck buyer will purchase only the tractor. The trailers are usually purchased and owned by fleets and shippers. This occurs in part because trucking fleets on average maintain 3 trailers per tractor and in some cases as many as 6 or more trailers per tractor. 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.

Based on these industry characteristics, EPA and NHTSA believe that the most straightforward regulatory approach for combination tractors and trailers is to establish standards for tractors separately from trailers. As discussed below in Section IX, the agencies are proposing standards for the tractors and their engines in this rulemaking, but are not proposing standards for trailers in this rulemaking. The agencies are requesting comment on potential standards for trailers, but will address standards for trailers in a separate rulemaking.

As with the other regulatory categories of heavy-duty vehicles, EPA and NHTSA have concluded that achieving reductions in GHG emissions and fuel consumption from combination tractors requires addressing both the cab and the engine, and EPA and NHTSA each are proposing standards that reflect this conclusion. The importance of the cab is that its design determines the amount of power that the engine must produce in moving the truck down the road. As illustrated in Figure I–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 of the engine for the variety of demands placed on the engine, regardless of the characteristics of the cab in which it is installed. The agencies intend for the proposed standards to result in the application of improved technologies for lower GHG emissions and fuel consumption for both the cab and the engine.

[23] The vast majority of combination tractor-trailers are used in highway applications, and these vehicles are the focus of this proposed program. A small fraction of combination tractors are used in off-road applications and are treated differently, as described in Section II.

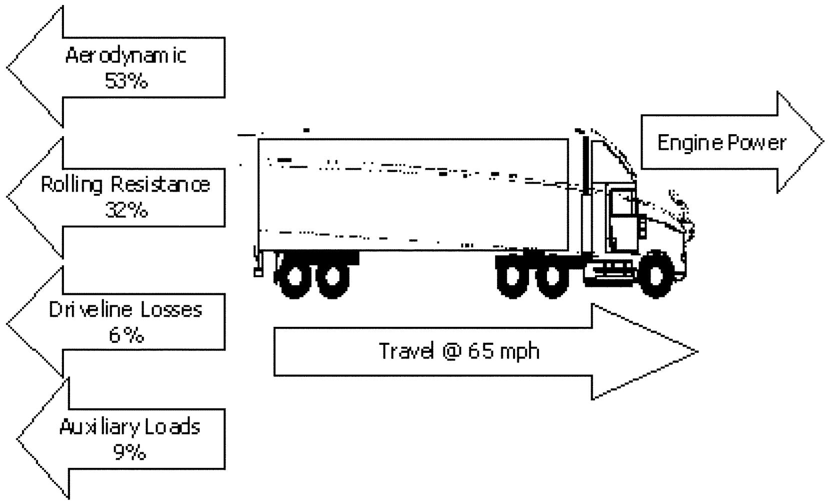

Figure I-1: Combination Tractor and Trailer Loads[24]

Accordingly, for Class 7 and 8 combination tractors, the agencies are each proposing two sets of standards. For vehicle-related emissions and fuel consumption, the agencies are proposing that tractor manufacturers meet respective vehicle-based standards. Compliance with the vehicle standard would typically be determined based on a customized vehicle simulation model, called the Greenhouse gas Emissions Model (GEM), which is consistent with the NAS Report recommendations to require compliance testing for combination tractors using vehicle simulation rather than chassis dynamometer testing. This compliance model was developed by EPA specifically for this proposal. It 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. These characteristics relate to key technologies appropriate for this subcategory of truck—including aerodynamic features, weight reductions, tire rolling resistance, the presence of idle-reducing technology, and vehicle speed limiters. The model would also assume the use of a representative typical engine, rather than a vehicle-specific engine, because engines are regulated separately and include an averaging, banking, and trading program separate from the vehicle program. The model and appropriate inputs would be used to quantify the overall performance of the vehicle in terms of CO_2 emissions and fuel consumption. The model's development and design, as well as the sources for inputs and the evaluation of the model's accuracy, are discussed in detail in Section II below and in Chapter 4 of the draft RIA.

EPA and NHTSA also considered developing respective alternative standards based on the direct testing of the emissions and fuel consumption of the entire vehicle for this category of vehicles, as measured using a chassis test procedure. This would be similar to the proposed approach for standards for HD pickups and vans discussed below. The agencies believe that such an approach warrants continued consideration. However, the agencies are not prepared to propose chassis-test-based standards at this time, primarily because of the very small number of chassis-test facilities that currently exist, but rather are proposing only the tractor standards and the engine-based standards discussed above. The agencies seek comment on the potential benefits and trade-offs of chassis-test-based standards for combination tractors.

(1) Proposed Standards for Class 7 and 8 Combination Tractors

The vehicle standards that EPA and NHTSA are proposing for Class 7 and 8 combination tractor manufacturers are based on several key attributes related to GHG emissions and fuel consumption that we believe reasonably represent the many differences in utility among these vehicles. The proposed 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.

Thus, the agencies have created nine subcategories within the Class 7 and 8 combination tractor category based on the differences in expected emissions and fuel consumption associated with the key attributes of GVWR, cab type, and roof height. Table I–2 presents the agencies' respective proposed standards for combination tractor manufacturers for the 2017 model year for illustration.

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[24] 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.

Table I-2: Heavy-duty Combination Tractor EPA Emissions Standards (g CO_2/ton-mile) and NHTSA Fuel Consumption Standards (gal/1,000 ton-mile)

2017 Model Year CO_2 Grams per Ton-Mile			
	Day Cab		Sleeper Cab
	Class 7	Class 8	Class 8
Low Roof	103	78	64
Mid Roof	103	78	69
High Roof	116	86	71
2017 Model Year Gallons of Fuel per 1,000 Ton-Mile			
	Day Cab		Sleeper Cab
	Class 7	Class 8	Class 8
Low Roof	10.1	7.7	6.3
Mid Roof	10.1	7.7	6.8
High Roof	11.4	8.5	7.0

In addition, the agencies are proposing separate performance standards for the engines manufactured for use in these trucks. EPA's proposed engine-based CO_2 standards and NHTSA's proposed engine-based fuel consumption standards would vary based on the expected weight class and usage of the truck into which the engine would be installed. EPA is also proposing engine-based N_2O and CH_4 standards for manufacturers of the engines used in combination tractors. EPA is proposing separate engine-based standards for these GHGs because the agency believes that N_2O and CH_4 emissions 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. However, NHTSA is not incorporating standards related to these GHGs due to their lack of influence on fuel consumption. EPA expects that manufacturers of current engine technologies would be able to comply with the proposed "cap" standards with little or no technological improvements; the value of the standards would be to prevent significant increases in these emissions as alternative technologies are developed and introduced in the future. Compliance with the proposed EPA engine-based CO_2 standards and the proposed NHTSA fuel consumption standards, as well as the proposed EPA N_2O and CH_4 standards, would be determined using the appropriate EPA engine test procedure, as discussed in Section II below.

As with the other categories of heavy-duty vehicles, EPA and NHTSA are proposing respective standards that would apply to Class 7 and 8 trucks at the time of production (as in Table I–2, above). In addition, EPA is proposing separate standards that would apply for a specified period of time in use. All of the proposed standards for these trucks, as well as details about the proposed provisions for certification and implementation of these standards, are discussed in more detail in Sections II, III, IV, and V below and in the draft RIA.

(ii) EPA Proposed Air Conditioning Leakage Standard for Class 7 and 8 Combination Tractors

In addition to the proposed EPA tractor- and engine-based standards for CO_2 and engine-based standards for N_2O, and CH_4 emissions, EPA is also proposing a separate standard to reduce leakage of HFC refrigerant from cabin air conditioning systems from combination tractors, to apply to the tractor manufacturer. This standard would be independent of the CO_2 tractor standard, as discussed below. Because the current refrigerant used widely in all these systems has a very high global warming potential, EPA is concerned about leakage of refrigerant over time.[25]

Because the interior volume to be cooled for most of these truck cabins is similar to that of light-duty trucks, the size and design of current truck A/C systems is also very similar. The proposed compliance approach for Class 7 and 8 tractors is therefore similar to that in the light-duty rule in that these proposed standards are design-based. Manufacturers would choose technologies from a menu of leak-reducing technologies sufficient to comply with the standard, as opposed to using a test to measure performance.

[25] The global warming potential for HFC–134a refrigerant of 1430 used in this proposal is consistent with the Intergovernmental Panel on Climate Change Fourth Assessment Report.

However, the proposed heavy-duty A/C provisions differ in two important ways from those established in the light-duty rule. First, the light-duty provisions were established as voluntary ways to generate credits towards the CO_2 g/mi standard, and EPA took into account the expected use of such credits in establishing the CO_2 emissions standards. In this rule, EPA is proposing that manufacturers actually meet a standard—as opposed to having the opportunity to earn a credit—for A/C refrigerant leakage. Thus, for this rule, refrigerant leakage is not accounted for in the development of the proposed CO_2 standards. We are taking this approach here recognizing that while the benefits of leakage control are almost identical between light-duty and heavy-duty vehicles on a per vehicle basis, these benefits on a per mile basis expressed as a percentage of overall GHG emissions are much smaller for heavy-duty vehicles due to their much higher CO_2 emissions rates and higher annual mileage when compared to light-duty vehicles. Hence a credit-based approach as done for light-duty vehicles would provide less motivation for manufacturers to install low leakage systems even though such systems represent a highly cost effective means to control GHG emissions. The second difference relates the expression of the leakage rate. The light-duty A/C leakage standard is expressed in terms of grams per year. For this heavy-duty rule, however, because of the wide variety of system designs and arrangements, a one-size-fits-all gram per year standard would likely be much less relevant, so EPA believes it is more appropriate to propose a standard in terms of percent of total refrigerant leakage per year. This requires the total refrigerant capacity of the A/C system to be taken into account in determining compliance. EPA believes that this proposed approach—a standard instead of a credit, and basing the standard on percent leakage over time—is more appropriate for heavy-duty tractors than the light-duty vehicle approach and that it will achieve the desired reductions in refrigerant leakage. Compliance with the standard would be determined through a showing by the tractor manufacturer that its A/C system incorporated a combination of low-leak technologies sufficient to meet the percent leakage of the standard. This proposed "menu" of technologies is very similar to that established in the light-duty GHG rule.[25]

Finally, EPA is not proposing an A/C system efficiency standard in this heavy-duty rulemaking, although an efficiency credit was a part of the light-duty rule. The much larger emissions of CO_2 from a heavy-duty tractor as compared to those from a light-duty vehicle mean that the relative amount of CO_2 that could be reduced through A/C efficiency improvements is very small. We request comment on this decision and whether EPA should reflect A/C system efficiency in the final program either as a credit or a stand-alone standard based on the same technologies and performance levels as the light-duty program.

A more detailed discussion of A/C related issues is found in Section II of this preamble.

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

Heavy-duty vehicles with GVWR between 8,501 and 10,000 lb are classified in the industry as Class 2b motor vehicles per the Federal Motor Carrier Safety Administration definition. As discussed above, Class 2b includes MDPVs that are regulated by the agencies under the light-duty vehicle program, and the agencies are not considering 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 (referred to in this proposal as "HD pickups and vans") together emit about 20 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 pick-up 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. These vehicle manufacturers are companies with major light-duty markets in the United States, primarily Ford, General Motors, and Chrysler. 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 believes it is appropriate to propose GHG standards for HD pickups and vans based on the whole vehicle, including the engine, expressed as grams per mile, consistent with the way these vehicles are regulated by EPA today for criteria pollutants. NHTSA believes it is appropriate to propose corresponding gallons per 100 mile fuel consumption standards that are likewise based on the whole vehicle. This complete vehicle approach being proposed by both agencies for HD pickups and vans is consistent with the recommendations of the NAS Committee in their 2010 Report. EPA and NHTSA also believe that the structure and many of the detailed provisions of the recently finalized light-duty GHG and fuel economy program, which also involves vehicle-based standards, are appropriate for the HD pickup and van GHG and fuel consumption standards as well, and this is reflected in the standards each agency is proposing, as detailed in Section II.C. These proposed 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 would be 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).[27]

For the light-duty GHG and fuel economy 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).[28] 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. For HD pickups and vans, the agencies believe that setting standards based on vehicle attributes is appropriate, but feel that a weight-based metric provides a better attribute than the footprint attribute utilized in the light-duty vehicle rulemaking. Weight-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 heavy-duty pick-up or van. EPA and NHTSA are therefore proposing standards for HD pickups and vans based on a "work factor" that combines their payload and towing capabilities, with an added adjustment for 4-wheel drive vehicles.

The agencies are proposing that each manufacturer's fleet average standard would be based on production volume-weighting of target standards for each vehicle that in turn are based on the vehicle's work factor. These target standards would be taken from a set of curves (mathematical functions), presented in Section II.C. EPA is also proposing that the CO_2 standards be phased in gradually starting in the 2014 model year, at 15–20–40–60–100 percent in model years 2014–2015–2016–2017–2018, respectively. The phase-in would take the form of a set of target standard curves, with increasing stringency in each model year, as detailed in Section II.C. The EPA standards proposed 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 baseline, as described in Sections II.C and III.B of this preamble. Section II.C also discusses the rationale behind the proposal of separate targets for diesel and gasoline vehicle standards. EPA is also proposing a manufacturer's alternative implementation schedule for

[25] At this time, EPA is considering approval of an alternative refrigerant, HFO–1234yf, which has a very low GWP. The proposed A/C leakage standard is designed to account for use of an alternative, low-GWP refrigerant. If in the future this refrigerant is approved and if it becomes widespread as a substitute for HFC–134a in mobile A/C systems, EPA may propose to revise or eliminate the leakage standard.

[27] 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).

[28] EISA requires CAFE standards for passenger cars and light trucks to be attribute-based; *see* 49 U.S.C. 32902(b)(3)(A).

model years 2016–2018 that parallels and is equivalent to NHTSA's first alternative described below.

NHTSA is proposing to allow manufacturers to select one of two fuel consumption standards alternatives for model years 2016 and later. To meet the EISA statutory requirement for three year regulatory stability, the first alternative would define individual gasoline vehicle and diesel vehicle fuel consumption target curves that would not change for model years 2016 and later. The proposed target curves for this alternative are presented in Section II.C. The second alternative would use target curves that are equivalent to the EPA program in each model year 2016 to 2018. Stringency for the alternatives has been selected to allow a manufacturer, through the use of the credit and deficit carry-forward provisions that the agencies are also proposing, to rely on the same product plans to satisfy either of these two alternatives, and also EPA requirements. NHTSA is also proposing that manufacturers may 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 proposed EPA and NHTSA standard curves are based on a set of vehicle, engine, and transmission technologies expected to be used to meet the recently established GHG emissions and fuel economy standards for model year 2012–2016 light-duty vehicles, with full consideration of how these technologies would 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
- Gasoline engine coupled cam phasing
- Diesel aftertreatment optimization
- Air conditioning system leakage reduction (for EPA program only)

See Section III.B for a detailed analysis of these and other potential technologies, including their feasibility, costs, and effectiveness when employed for reducing fuel consumption and CO_2 emissions in HD pickups and vans.

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. We are proposing that these vehicles generally be regulated as Class 2b through 8 vocational vehicles, as described in Section I.C(2)(c), because, like other vocational vehicles, we have little information on baseline aerodynamic performance and expectations for improvement. However, a sizeable subset of these incomplete vehicles, often called cab-chassis vehicles, are sold by the vehicle manufacturers in configurations with 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. We are proposing that these vehicles be included in the chassis-based HD pickup and van program. These proposed provisions are described in Section V.B.

In addition to proposed EPA CO_2 emission standards and the proposed NHTSA fuel consumption standards for HD pickups and vans, EPA is also proposing standards for two additional GHGs, N_2O and CH_4, as well as standards for air conditioning-related HFC emissions. These standards are discussed in more detail in Section II.E. Finally, EPA is proposing standards that would apply to HD pickups and vans in use. All of the proposed standards for these HD pickups and vans, as well as details about the proposed provisions for certification and implementation of these standards, are discussed in Section II.C.

(c) Class 2b–8 Vocational Vehicles

Class 2b–8 vocational vehicles consist of a wide variety of vehicle types. Some of the primary applications for vehicles in this segment include delivery, refuse, utility, dump, and cement trucks; transit, shuttle, and school buses; emergency vehicles, motor homes,[29] tow trucks, among others. These vehicles and their engines contribute approximately 15 percent of today's heavy-duty truck sector GHG emissions.

Manufacturing of vehicles in this segment of the industry is organized in a more complex way than that of the other heavy-duty categories. Class 2b–8 vocational vehicles are often built as a chassis with an installed engine and an installed transmission. Both the engine and transmissions are typically manufactured by other manufacturers and the chassis manufacturer purchases and installs them. Many of the same companies that build Class 7 and 8 tractors are also in the Class 2b–8 chassis manufacturing market. The chassis is typically then sent to a body manufacturer, which completes the vehicle by installing the appropriate feature—such as dump bed, delivery box, or utility bucket—onto the chassis. Vehicle body manufacturers tend to be small businesses that specialize in specific types of bodies or specialized features.

EPA and NHTSA are proposing that in this vocational vehicle category the chassis manufacturers be the focus of the proposed GHG and fuel consumption standards. They play a central role in the manufacturing process, and the product they produce—the chassis with engine and transmissions—includes the primary technologies that affect emissions and fuel consumption. They also constitute a much more limited group of manufacturers for purposes of developing a regulatory program. In contrast, a focus on the body manufacturers would be much less practical, since they represent a much more diverse set of manufacturers, and the part of the vehicle that they add has a very limited impact on opportunities to reduce GHG emissions and fuel consumption (given the limited role that aerodynamics plays in the types of lower speed operation typically found with vocational vehicles). Therefore, the proposed standards in this vocational vehicle category would apply to the chassis manufacturers of all heavy-duty vehicles not otherwise covered by the HD pickup and van standards or Class 7 and 8 combination tractor standards discussed above. The agencies request comment on our proposed focus on chassis manufacturers.

As discussed above, EPA and NHTSA have concluded that reductions in GHG emissions and fuel consumption require addressing both the vehicle and the engine. As discussed above for Class 7 and 8 combination tractors, the agencies are each proposing two sets of standards for Class 2b–8 vocational vehicles. For vehicle-related emissions and fuel consumption, the agencies are proposing standards for chassis manufacturers: EPA CO_2 (g/ton-mile) standards and NHTSA fuel consumption (gal/1,000 ton-mile) standards). Also as in the case of Class 7 and 8 tractors, we propose to use GEM, a customized vehicle simulation model, to determine compliance with the vocational vehicle standards. The primary manufacturer-generated input

[29] Again, we note that NHTSA's proposed fuel consumption standards would not apply to non-commercial vehicles like motor homes.

into the proposed compliance model for this category of trucks would be a measure of tire rolling resistance, as discussed further below, because tire improvements are the primary means of vehicle improvement available at this time. The model would also assume the use of a typical representative engine in the simulation, resulting in an overall value for CO_2 emissions and one for fuel consumption. As is the case for combination tractors, the manufacturers of the engines intended for vocational vehicles would be subject to separate engine-based standards.

(i) Proposed Standards for Class 2b–8 Vocational Vehicles

Based on our analysis and research, the agencies believe that the primary opportunity for reductions in vocational vehicle GHG emissions and fuel consumption will be through improved engine technologies and improved tire rolling resistance. For engines, as proposed for combination tractors, EPA and NHTSA are proposing separate standards for the manufacturers of engines used in Class 2b–8 vocational vehicles. EPA's proposed engine-based CO_2 standards and NHTSA's proposed engine-based fuel consumption standards would vary based on the expected weight class and usage of the truck into which the engine would be installed. The agencies propose to use the groupings EPA currently uses for other heavy-duty engine standards—light heavy-duty, medium heavy-duty, and heavy heavy-duty, as discussed in Section II below.

Tire rolling resistance is closely related to the weight of the vehicle. Therefore, we propose that the vehicle-based standards for these trucks vary according to one key attribute, GVWR. For this initial HD rulemaking, we propose that these standards be based on the same groupings of truck weight classes used for the engine standards—light heavy-duty, medium heavy-duty, and heavy heavy-duty. These groupings are appropriate for the proposed vehicle-based standards because they parallel the general divisions among key engine characteristics, as discussed in Section II.

The agencies intend to monitor the development of and production feasibility of new vehicle-related GHG and fuel consumption reduction improving technologies and consider including these technologies in future rulemakings. As discussed below, we are including provisions to account for and credit the use of hybrid technology as a technology that can reduce emissions and fuel consumption. Hybrid technology can currently be a cost-effective technology in certain specific vocational applications, and the agencies want to recognize and promote the use of this technology. We also are proposing a mechanism whereby credits can be generated by use of other technologies not included in the compliance model. (*See* Sections I.E and IV below.)

Table I–3 presents EPA's proposed CO_2 standards and NHTSA's proposed fuel consumption standards for chassis manufacturers of Class 2b through Class 8 vocational vehicles for the 2017 model year for illustrative purposes.

Table I-3: Proposed 2017 Class 2b-8 Vocational Vehicle EPA CO_2 Standards and NHTSA Fuel Consumption Standards

EPA CO_2 (gram/ton-mile) Standard Effective 2017 Model Year			
	Light Heavy-Duty Class 2b-5	Medium Heavy-Duty Class 6-7	Heavy Heavy-Duty Class 8
CO_2 Emissions	344	204	107
NHTSA Fuel Consumption (gallon per 1,000 ton-mile) Standard Effective 2017 Model Year			
	Light Heavy-Duty Class 2b-5	Medium Heavy-Duty Class 6-7	Heavy Heavy-Duty Class 8
Fuel Consumption	33.8	20.0	10.5

At this time, NHTSA and EPA are not prepared to propose alternative standards based on a whole-vehicle chassis test for vocational vehicles in this initial heavy-duty rulemaking. As discussed above for combination tractors, the primary reason is the very small number of chassis-test facilities that currently exist. Thus, the agencies are proposing only the compliance-model based standards and engine standards discussed above, and seek comment on the appropriateness of chassis-test-based standards for the vocational vehicle category.

For vocational vehicles using hybrid technology, the agencies are proposing two specialized approaches to allow manufacturers to gain credit for the emissions and fuel consumption reductions associated with hybrid technology. One option to account for the reductions associated with vocational vehicles using hybrid technology would compare vehicle-based chassis tests with and without the hybrid technology. The other option would allow a manufacturer to simulate the operation of the hybrid system in an engine-based test. The options are further discussed in Section IV.

The proposed program also provides for opportunities to generate credits for technologies not measured by the GEM, again described more fully in Section IV.

As mentioned above for Class 7 and 8 combination tractors, EPA believes that N_2O and CH_4 emissions 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. Therefore, for Class 2b–8 vocational vehicles, EPA is not proposing separate vehicle-based standards for these GHGs, but is proposing engine-based N_2O and CH_4 standards for manufacturers of the engines to be used in vocational vehicles. EPA expects that manufacturers of current engine technologies would be able to comply with the proposed "cap" standards with little or no technological improvements; the value of the standards would be in that they would prevent significant increases in these emissions as alternative technologies are developed and introduced in the future. Compliance with the proposed EPA engine-based CO_2 standards and the proposed NHTSA fuel consumption standards, as well as the proposed EPA N_2O and CH_4 standards, would be determined using the appropriate EPA engine test procedure, as discussed in Section II below.

As with the other regulatory categories of heavy-duty vehicles, EPA and NHTSA are proposing standards that would 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. All of the proposed standards for these trucks, 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.

EPA is not proposing A/C refrigerant leakage standards for Class 2b–8 vocational vehicles at this time, primarily because of the number of entities involved in their manufacture and thus the potential for different entities besides the chassis manufacturer to be involved in the A/C system production and installation. EPA requests comment on how A/C standards might practically be applied to manufacturers of vocational vehicles.

(d) What Manufacturers Are Not Covered by the Proposed Standards?

EPA and NHTSA are proposing to temporarily defer the proposed 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. We are not aware of any manufacturers of HD pickups and vans that meet these criteria. For each of the other categories and for engines, we have identified a small number of manufacturers that would appear to qualify as small businesses. The production of these companies is small, and we believe that deferring the standards for these companies at this time would have a negligible impact on the GHG emission reductions and fuel consumption reductions that the program would otherwise achieve. We request comment on our assumption that the impact of these exemptions for small businesses will be small and further whether it will be possible to circumvent the regulations by creating new small businesses to displace existing manufacturers. We discuss the specific deferral provisions in more detail in Section II.

The agencies will consider appropriate GHG emissions and fuel consumption standards for these entities as part of a future regulatory action.

D. Summary of Costs and Benefits of the HD National Program

This section summarizes the projected costs and benefits of the proposed NHTSA fuel consumption and EPA GHG emissions standards. These projections help to inform the agencies' choices among the alternatives considered and provide further confirmation that the proposed standards are an appropriate choice within the spectrum of choices allowable under the agencies' respective statutory criteria. NHTSA and EPA have used common projected costs and benefits as the bases for our respective standards.

The agencies have analyzed in detail the projected costs and benefits of the proposed GHG and fuel consumption standards. Table I–4 shows estimated lifetime discounted costs, benefits and net benefits for all heavy-duty vehicles projected to be sold in model years 2014–2018. These figures depend on estimated values for the social cost of carbon (SCC), as described in Section VIII.G.

Table I-4: Estimated Lifetime Discounted Costs, Benefits, and Net Benefits for 2014-2018 Model Year HD Vehicles assuming the \$22/ton SCC Value[a,b] (2008 dollars)

3% Discount Rate	$billions
Costs	$7.7
Benefits	$49
Net Benefits	$41
7% Discount Rate	
Costs	$7.7
Benefits	$34
Net Benefits	$27

Notes:

[a] Although the agencies estimated the benefits associated with four different values of a one ton CO_2 reduction (SCC: \$5, \$22, \$36, \$66), for the purposes of this overview presentation of estimated costs and benefits we are showing the benefits associated with the marginal value deemed to be central by the interagency working group on this topic: \$22 per ton of CO_2, in 2008 dollars and 2010 emissions and fuel consumption. As noted in Section VIII.F, SCC increases over time.

[b] Note that net present value of reduced GHG emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5, 3, and 2.5 percent) is used to calculate net present value of SCC for internal consistency. Refer to Section VIII.F for more detail.

Table I–5 shows the estimated lifetime reductions in CO_2 emissions (in million metric tons (MMT)) and fuel consumption for all heavy-duty vehicles sold in the model years 2014–2018. The values in Table I–5 are projected lifetime totals for each model year and are not discounted. The two agencies' standards together comprise the HD National Program, and the agencies' respective GHG emissions and fuel consumption standards, jointly, are the source of the benefits and costs of the HD National Program.

Table I–5 are projected lifetime totals for each model year and are not discounted. The two agencies' standards together comprise the HD National Program, and the agencies' respective GHG emissions and fuel consumption standards, jointly, are the source of the benefits and costs of the HD National Program.

Table I-5: Estimated Lifetime Reductions in Fuel Consumption and CO_2 Emissions for 2014-2018 Model Year HD Vehicles

		2014	2015	2016	2017	2018	Total
All Heavy-Duty Vehicles	Fuel (billion gallons)	3.0	3.1	3.5	5.2	5.8	20.5
	Fuel (billion barrels)	0.07	0.07	0.08	0.12	0.14	0.5
	CO_2 (MMT)[a]	36.2	37.6	41.6	62.0	68.7	246

[a] Includes upstream and downstream CO_2 reductions.

Table I–6 shows the estimated lifetime discounted benefits for all heavy-duty vehicles sold in model years 2014–2018. Although the agencies estimated the benefits associated with four different values of a one ton CO_2 reduction ($5, $22, $36, $66), for the purposes of this overview presentation of estimated benefits the agencies are showing the benefits associated with one of these marginal values, $22 per ton of CO_2, in 2008 dollars and 2010 emissions. Table I–6 presents benefits based on the $22 value. Section VIII.F presents the four marginal values used to estimate monetized benefits of CO_2 reductions and Section VIII presents the program benefits using each of the four marginal values, which represent only a partial accounting of total benefits due to omitted climate change impacts and other factors that are not readily monetized. The values in the table are discounted values for each model year of vehicles throughout their projected lifetimes. The analysis includes other economic impacts such as fuel savings, energy security, and other externalities such as reduced accidents, congestion and noise. However, the analysis supporting the proposal omits other impacts such as benefits related to non-GHG emission reductions. The lifetime discounted benefits are shown for one of four different SCC values considered by EPA and NHTSA. The values in Table I–6 do not include costs associated with new technology required to meet the GHG and fuel consumption standards.

Table I-6: Estimated Lifetime Discounted Benefits for 2014-2018 Model Year HD Vehicles Assuming the $22/ton SCC Value[a,b] (billions of 2008 dollars)

Discount Rate	Model Year					
	2014	2015	2016	2017	2018	Total
3%	$7.0	$7.3	$8.2	$12	$14	$49
7%	$5.4	$5.4	$5.9	$8.4	$9.1	$34

Notes:

[a] The analysis includes impacts such as the economic value of reduced fuel consumption and accompanying climate-related economic benefits from reducing emissions of CO_2 (but not other GHGs), and reductions in energy security externalities caused by U.S. petroleum consumption and imports. The analysis also includes economic impacts stemming from additional heavy-duty vehicle use, such as the economic damages caused by accidents, congestion and noise.

[b] Note that 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 (SCC at 5, 3, and 2.5 percent) is used to calculate net present value of SCC for internal consistency. Refer to Section VIII.F for more detail.

Table I–7 shows the agencies' estimated lifetime fuel savings, lifetime CO_2 emission reductions, and the monetized net present values of those fuel savings and CO_2 emission reductions. The gallons of fuel and CO_2 emission reductions are projected lifetime values for all vehicles sold in the model years 2014–2018. The estimated fuel savings in billions of barrels and the GHG reductions in million metric tons of CO_2 shown in Table I–7 are totals for the five model years throughout their projected lifetime and are not discounted. The monetized values shown in Table I–7 are the summed values of the discounted monetized-fuel consumption and monetized-CO_2 reductions for the five model years 2014–2018 throughout their lifetimes. The monetized values in Table I–7 reflect both a 3 percent and a 7 percent discount rate as noted.

Table I-7: Estimated Lifetime Reductions and Associated Discounted Monetized Benefits for 2014-2018 Model Year HD Vehicles (monetized values in 2008 dollars)

	Amount	$ value (billions)
Fuel Consumption Reductions	0.5 billion barrels	$42, 3% discount rate $28, 7% discount rate
CO_2 Emission Reductions[a] Valued assuming $22/ton CO_2 in 2010	246 MMT CO_2	$4.1[b]

Notes:

[a] Includes both upstream and downstream CO_2 emission reductions.

[b] Note that 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 (SCC at 5, 3, and 2.5 percent) is used to calculate net present value of SCC for internal consistency. Refer to Section VIII.F for more detail.

Table I–8 shows the estimated incremental and total technology outlays for all heavy-duty vehicles for each of the model years 2014–2018. The technology outlays shown in Table I–8 are for the industry as a whole and do not account for fuel savings associated with the program.

Table I-8: Estimated Incremental Technology Outlays for 2014-2018 Model Year HD Vehicles (billions of 2008 dollars)

	2014	2015	2016	2017	2018	Total
All Heavy-Duty Vehicles	$1.3	$1.3	$1.5	$1.6	$2.0	$7.7

Table I–9 shows EPA's estimated incremental cost increase of the average new heavy-duty vehicles for each model year 2014–2018. The values shown are incremental to a baseline vehicle and are not cumulative.

Table I-9: Estimated Incremental Increase in Average Cost for 2014-2018 Model Year HD Vehicles (2008 dollars per unit)

	2014	2015	2016	2017	2018
Combination Tractors	$5,896	$5,733	$5,480	$6,150	$5,901
HD Pickups &Vans	$225	$292	$567	$848	$1,411
Vocational Trucks	$374	$367	$400	$392	$359

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E. Program Flexibilities

For each of the heavy-duty vehicle and heavy-duty engine categories for which we are proposing respective standards, EPA and NHTSA are also proposing provisions designed to give manufacturers a degree of flexibility in complying with the standards. These proposed provisions have enabled the agencies to consider overall standards that are more stringent and that would 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.[30] We believe that incorporating carefully structured regulatory flexibility provisions into the overall program is an important way to achieve each agency's goals for the program.

NHTSA's and EPA's proposed flexibility provisions are essentially identical to each other in structure and function. For combination tractor and vocational vehicle categories and for heavy-duty engines, we are proposing 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 proposed ABT provisions are patterned on existing EPA ABT programs and would allow a vehicle manufacturer to reduce CO_2 emission and fuel consumption levels

[30] 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 heavy-duty fuel efficiency under 49 U.S.C. 32902(k).

further than the level of the standard for one or more vehicles to generate ABT credits. The manufacturer could then use those credits to offset higher emission or fuel consumption levels in other similar vehicles, "bank" the credits for later use, or "trade" the credits to another manufacturer. We are proposing similar ABT provisions for manufacturers of heavy-duty engines. For HD pickups and vans, we are proposing a fleet averaging system very similar to the light-duty GHG and CAFE fleet averaging system.

To best ensure that the overall emission and fuel consumption reductions of the program would be achieved and to minimize any effect on the ability of the market to respond to consumer needs, the agencies propose to restrict the use of averaging to limited sets of vehicles and engines expected to have similar emission or fuel consumption characteristics. For example, averaging would be allowed among Class 7 low-roof day cab vehicles, but not among those vehicles and Class 8 sleeper cabs or vocational vehicles. Also, we propose that credits generated by vehicles not be applicable to engine compliance, and vice versa. For HD pickups and vans, we propose that fleet averaging be allowed with minimum restriction within the HD pickup and van category.

In addition to ABT, the agencies are proposing that a manufacturer that reduces CO_2 emissions and fuel consumption below required levels prior to the beginning of the program be allowed to generate the same number of credits ("early credits") that they would after the program begins.

The agencies are also proposing that manufacturers that show improvements in CO_2 emissions and fuel consumption and incorporate certain technologies (including hybrid powertrains, Rankine engines, or electric vehicles) be eligible for special "advanced technology" credits. Unlike other credits in this proposal, the advanced technology credits could be applied to any heavy-duty vehicle or engine, and not be limited to the vehicle category generating the credit.

The technologies eligible for advanced technology credits above lend themselves to straightforward methodologies for quantifying the emission or fuel consumption reductions. For other technologies which can reduce CO_2 and fuel consumption, but for which there do not yet exist established methods for quantifying reductions, the agencies still seek to encourage the development of such innovative technologies, and are therefore proposing special "innovative technology" credits. These innovative technology credits would apply to technologies that are shown to produce emission and fuel consumption reductions that are not adequately recognized on the current test procedures and that are not yet in widespread use. Manufacturers would need to quantify the reductions in fuel consumption and CO_2 emissions that the technology could achieve, above and beyond those achieved on the existing test procedures. As with ABT, we propose that the use of innovative technology credits be only allowed among vehicles and engines expected to have similar emissions and fuel consumption characteristics (*e.g.,* within each of the nine Class 7 & 8 combination tractor subcategories, or within each of the three Class 2b–8 vocational vehicle subcategories).

A detailed discussion of each agency's ABT, early credit, advanced technology, and innovative technology provisions for each regulatory category of heavy-duty vehicles and engines is found in Section IV below.

F. EPA and NHTSA Statutory Authorities

(1) EPA Authority

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-GHGs; 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 proposal implements a specific provision from Title II, section 202(a).[31] 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 for greenhouse gases, section 202(a) authorizes EPA to issue standards applicable to emissions of those pollutants from new motor vehicles.

Any standards under CAA section 202(a)(1) "shall be applicable to such vehicles * * * for their useful life." Emission standards set by the EPA under CAA section 202(a)(1) are technology-based, as the levels chosen must be premised on a finding of technological feasibility. Thus, standards promulgated under CAA section 202(a) are to take effect only "after providing 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" (section 202(a)(2); *see also NRDC* v. *EPA*, 655 F.2d 318, 322 (DC Cir. 1981)). EPA is afforded considerable discretion under section 202(a) when assessing issues of technical feasibility and availability of lead time to implement new technology. Such determinations are "subject to the restraints of reasonableness", which "does not open the door to 'crystal ball' inquiry." *NRDC*, 655 F.2d at 328, quoting *International Harvester Co.* v. *Ruckelshaus*, 478 F.2d 615, 629 (DC Cir. 1973). However, "EPA is not obliged to provide detailed solutions to every engineering problem posed in the perfection of the trap-oxidizer. In the absence of theoretical objections to the technology, the agency need only identify the major steps necessary for development of the device, and give plausible reasons for its belief that the industry will be able to solve those problems in the time remaining. The EPA is not required to rebut all speculation that unspecified factors may hinder 'real world' emission control." *NRDC,* 655 F.2d at 333–34. In developing such technology-based standards, EPA has the discretion to consider different standards for appropriate groupings of vehicles ("class or classes of new motor vehicles"), or a single standard for a larger grouping of motor vehicles (*NRDC,* 655 F.2d at 338).

Although standards under CAA section 202(a)(1) are technology-based, they are not based exclusively on technological capability. EPA has the discretion to consider and weigh various factors along with technological feasibility, such as the cost of compliance (*see* section 202(a)(2)), lead time necessary for compliance (section 202(a)(2)), safety (*see NRDC,* 655 F.2d at 336 n. 31) and other impacts on consumers, and energy impacts associated with use of the technology. *See George E. Warren Corp.* v. *EPA*, 159

[31] *See* 42 U.S.C. 7521(a).

F.3d 616, 623–624 (DC Cir. 1998) (ordinarily permissible for EPA to consider factors not specifically enumerated in the CAA). *See also Entergy Corp.* v. *Riverkeeper, Inc.*, 129 S.Ct. 1498, 1508–09 (2009) (congressional silence did not bar EPA from employing cost-benefit analysis under the Clean Water Act absent some other clear indication that such analysis was prohibited; rather, silence indicated discretion to use or not use such an approach as the agency deems appropriate).

In addition, EPA has clear authority to set standards under CAA section 202(a) that are technology forcing when EPA considers that to be appropriate, but is not required to do so (as compared to standards set under provisions such as section 202(a)(3) and section 213(a)(3)). EPA has interpreted a similar statutory provision, CAA section 231, as follows:

While the statutory language of section 231 is not identical to other provisions in title II of the CAA that direct EPA to establish technology-based standards for various types of engines, EPA interprets its authority under section 231 to be somewhat similar to those provisions that require us to identify a reasonable balance of specified emissions reduction, cost, safety, noise, and other factors. *See, e.g., Husqvarna AB* v. *EPA,* 254 F.3d 195 (DC Cir. 2001) (upholding EPA's promulgation of technology-based standards for small non-road engines under section 213(a)(3) of the CAA). However, EPA is not compelled under section 231 to obtain the "greatest degree of emission reduction achievable" as per sections 213 and 202 of the CAA, and so EPA does not interpret the Act as requiring the agency to give subordinate status to factors such as cost, safety, and noise in determining what standards are reasonable for aircraft engines. Rather, EPA has greater flexibility under section 231 in determining what standard is most reasonable for aircraft engines, and is not required to achieve a "technology forcing" result (70 FR 69664 and 69676, November 17, 2005).

This interpretation was upheld as reasonable in *NACAA* v. *EPA,* 489 F.3d 1221, 1230 (DC Cir. 2007). CAA section 202(a) does not specify the degree of weight to apply to each factor, and EPA accordingly has discretion in choosing an appropriate balance among factors. *See Sierra Club* v. *EPA,* 325 F.3d 374, 378 (DC Cir. 2003) (even where a provision is technology-forcing, the provision "does not resolve how the Administrator should weigh all [the statutory] factors in the process of finding the 'greatest emission reduction achievable' "). *Also see Husqvarna AB* v. *EPA,* 254 F.3d 195, 200 (DC Cir. 2001) (great discretion to balance statutory factors in considering level of technology-based standard, and statutory requirement "to [give appropriate] consideration to the cost of applying * * * technology" does not mandate a specific method of cost analysis); *see also Hercules Inc.* v. *EPA,* 598 F.2d 91, 106 (DC Cir. 1978) ("In reviewing a numerical standard the agencies must ask whether the agency's numbers are within a zone of reasonableness, not whether its numbers are precisely right"); *Permian Basin Area Rate Cases,* 390 U.S. 747, 797 (1968) (same); *Federal Power Commission* v. *Conway Corp.,* 426 U.S. 271, 278 (1976) (same); *Exxon Mobil Gas Marketing Co.* v. *FERC,* 297 F.3d 1071, 1084 (DC Cir. 2002) (same).

(a) EPA Testing Authority

Under section 203 of the CAA, sales of vehicles are prohibited unless the vehicle is covered by a certificate of conformity. EPA issues certificates of conformity pursuant to section 206 of the Act, based on (necessarily) pre-sale testing conducted either by EPA or by the manufacturer. The Heavy-duty Federal Test Procedure (Heavy-duty FTP) and the Supplemental Engine Test (SET) are used for this purpose. Compliance with standards is required not only at certification but throughout a vehicle's useful life, so that testing requirements may continue post-certification. Useful life standards may apply an adjustment factor to account for vehicle emission control deterioration or variability in use (section 206(a)).

(b) EPA established the Light-duty FTP for emissions measurement in the early 1970s. In 1976, in response to the Energy Policy and Conservation Act, EPA extended the use of the Light-duty FTP to fuel economy measurement (*See* 49 U.S.C. 32904(c)). EPA can determine fuel efficiency of a vehicle by measuring the amount of CO_2 and all other carbon compounds (*e.g.,* total hydrocarbons and carbon monoxide (CO)), and then, by mass balance, calculating the amount of fuel consumed.

(b) EPA Enforcement Authority

Section 207 of the CAA grants EPA broad authority to require manufacturers to remedy vehicles if EPA determines there are a substantial number of noncomplying vehicles. In addition, section 205 of the CAA authorizes EPA to assess penalties of up to $37,500 per vehicle for violations of various prohibited acts specified in the CAA. In determining the appropriate penalty, EPA must consider a variety of factors such as the gravity of the violation, the economic impact of the violation, the violator's history of compliance, and "such other matters as justice may require."

(2) NHTSA Authority

EISA authorizes NHTSA to create a fuel efficiency improvement program for "commercial medium- and heavy-duty on-highway vehicles and work trucks" [32] 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.

Since this is the first rulemaking that NHTSA has conducted under 49 U.S.C. 32902(k)(2), the agency must interpret these elements and factors in the context of setting standards, choosing metrics, and determining test methods and compliance/enforcement mechanisms. Congress also gave NHTSA the authority to set separate standards for different classes of these vehicles, but required that all standards adopted provide not less than four full model years of regulatory lead-time and three full model years of regulatory stability.

In EISA, Congress required NHTSA to prescribe separate average fuel economy standards for passenger cars and light trucks in accordance with the provisions in 49 U.S.C. section 32902(b), and to prescribe standards for work trucks and commercial medium- and heavy-duty vehicles in accordance with the provisions in 49 U.S.C. section 32902(k). *See* 49 U.S.C. section 32902(b)(1). We note that Congress also added in EISA a requirement that NHTSA shall issue regulations prescribing fuel economy standards for at least 1, but not more than 5, model years. *See* 49 U.S.C. section 32902(b)(3)(B). For purposes of the fuel efficiency standards that the agency is proposing for HD vehicles and engines, NHTSA believes that one permissible reading of the statute is that Congress did not intend for the 5-year maximum limit to apply to standards promulgated in accordance with 49 U.S.C. section 32902(k), given the language in

[31] "Commercial medium- and heavy-duty on-highway vehicles" are defined at 49 U.S.C. 32901(a)(7), and "work trucks" are defined at (a)(19).

32902(b)(1). Based on this interpretation, NHTSA proposes that the standards ultimately finalized for HD vehicles and engines would remain in effect indefinitely at their 2018 or 2019 model year levels until amended by a future rulemaking action. In any future rulemaking action to amend the standards, NHTSA would ensure not less than four full model years of regulatory lead-time and three full model years of regulatory stability. NHTSA seeks comment on this interpretation of EISA.

(a) NHTSA Testing Authority

49 U.S.C. 32902(k)(2) states that NHTSA must adopt and implement appropriate, cost-effective, and technologically feasible test methods and measurement metrics as part of the fuel efficiency improvement program.

(b) NHTSA Enforcement Authority

49 U.S.C. 32902(k)(2) also states that NHTSA must adopt and implement appropriate, cost-effective, and technologically feasible compliance and enforcement protocols for the fuel efficiency improvement program.

In 49 U.S.C. 32902(k)(2), Congress did not speak directly to the "compliance and enforcement protocols" it envisioned. Instead, it left the matter generally to the Secretary. Congress' approach is unlike CAFE enforcement for passenger cars and light trucks, where Congress specified a program where a manufacturer either complies with standards or pays civil penalties. But Congress did not specify in 49 U.S.C. 32902(k) what it precisely meant in directing NHTSA to develop "compliance and enforcement protocols." It appears, therefore, that Congress has assigned this matter to the agency's discretion.

The statute is silent with respect to how "protocol" should be interpreted. The term "protocol" is imprecise. For example, in a case interpreting section 301(c)(2) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the DC Circuit noted that the word "protocols" has many definitions that are not much help. *Kennecott Utah Copper Corp., Inc.* v. *U.S. Dept. of Interior,* 88 F.3d. 1191, 1216 (DC Cir. 1996). Section 301(c)(2) of CERCLA prescribed the creation of two types of procedures for conducting natural resources damages assessments. The regulations were to specify (a) "standard procedures for simplified assessments requiring minimal field observation" (the "Type A" rules), and (b) "alternative protocols for conducting assessments in individual cases" (the "Type B" rules).[33] The court upheld the challenged provisions, which were a part of a set of rules establishing a step-by-step procedure to evaluate options based on certain criteria, and to make a decision and document the results.

Taking the considerations above into account, including Congress' instructions to adopt and implement compliance and enforcement protocols, and the Secretary's authority to formulate policy and make rules to fill gaps left, implicitly or explicitly, by Congress, the agency interprets "protocol" in the context of EISA as authorizing the agency to determine both whether manufacturers have complied with the standards, and to establish the enforcement mechanisms and decision criteria for non-compliance. NHTSA seeks comment on its interpretation of this statutory requirement.

G. Future HD GHG and Fuel Consumption Rulemakings

This proposal represents a first regulatory step by NHTSA and EPA to address the multi-faceted challenges of reducing fuel use and greenhouse gas emissions from these vehicles. By focusing on existing technologies and well-developed regulatory tools, the agencies are able to propose rules that we believe will produce real and important reductions in GHG emissions and fuel consumption within only a few years. Within the context of this regulatory timeframe, our proposal is very aggressive—with limited lead time compared to historic heavy-duty regulations—but pragmatic in the context of technologies that are available.

While we are now only proposing this first step, it is worthwhile to consider how future regulations that may follow this step may be constructed. Technologies such as hybrid drivetrains, advanced bottoming cycle engines, and full electric vehicles are promoted in this first step through incentive concepts as discussed in Section IV, but we believe that these advanced technologies would not be necessary to meet the proposed standards, which are premised on the use of existing technologies. When we begin our future work to develop a possible next set of regulatory standards, the agencies expect these advanced technologies to be an important part of the regulatory program and will consider them in setting the stringency of any standards beyond the 2018 model year.

[33] *State of Ohio* v. *U.S. Dept. of Interior,* 880 F.2d 432, 439 (DC Cir. 1989).

We will not only consider the progress of technology in our future regulatory efforts, but the agencies are also committed to fully considering a range of regulatory approaches. To more completely capture the complex interactions of the total vehicle and the potential to reduce fuel consumption and GHG emissions through the optimization of those interactions may require a more sophisticated approach to vehicle testing than we are proposing for the largest heavy-duty vehicles. In future regulations, the agencies expect to fully evaluate the potential to expand the use of vehicle compliance models to reflect engine and drivetrain performance. Similarly, we intend to consider the potential for complete vehicle testing using a chassis dynamometer, not only as a means for compliance, but also as a complementary tool for the development of more complex vehicle modeling approaches. In considering these more comprehensive regulatory approaches, the agencies will also reevaluate whether separate regulation of trucks and engines remains necessary.

In addition to technology and test procedures, vehicle and engine drive cycles are an important part of the overall approach to evaluating and improving vehicle performance. EPA, working through the WP.29 Global Technical Regulation process, has actively participated in the development of a new World Harmonized Duty Cycle for heavy-duty engines. EPA is committed to bringing forward these new procedures as part of our overall comprehensive approach for controlling criteria and GHG emissions. However, we believe the important issues and technical work related to setting new criteria emissions standards appropriate for the World Harmonized Duty Cycle are significant and beyond the scope of this rulemaking. Therefore, the agencies are not proposing to adopt these test procedures in this proposal, but we are ready to work with interested stakeholders to adopt these procedures in a future action.

As with this proposal, our future efforts will be based on collaborative outreach with the stakeholder community and will be focused on a program that delivers on our energy security and environmental goals without restricting the industry's ability to produce a very diverse range of vehicles serving a wide range of needs.

II. Proposed GHG and Fuel Consumption Standards for Heavy-Duty Engines and Vehicles

This section describes the standards and implementation dates that the agencies are proposing for the three categories of heavy-duty vehicles. The agencies have performed a technology analysis to determine the level of standards that we believe would be appropriate, cost-effective, and feasible during the rulemaking timeframe. This analysis, described in Section III and in more detail in the draft RIA Chapter 2, considered:

- The level of technology that is incorporated in current new trucks,
- The available data on corresponding 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 2018 model year,
- The effectiveness and cost of these technologies,
- Projections of future U.S. sales for trucks, and
- Forecasts of manufacturers' product redesign schedules.

A. What vehicles would be affected?

EPA and NHTSA are proposing standards for heavy-duty engines and also for what we refer to generally as "heavy-duty trucks." As noted in Section I, for purposes of this preamble, the term "heavy-duty" or "HD" is used to apply to all highway vehicles and engines that are not regulated by the light-duty vehicle, light-duty truck and medium-duty passenger vehicle greenhouse gas and CAFE standards issued for MYs 2012–2016. Thus, in this notice, unless specified otherwise, the heavy-duty category incorporates all vehicles rated with GVWR greater than 8,500 pounds, and the engines that power these vehicles, except for MDPVs. The CAA defines heavy-duty vehicles as trucks, buses or other motor vehicles with GVWR exceeding 6,000 pounds. *See* CAA section 202(b)(3). In the context of the CAA, the term HD as used in these proposed rules thus refers to a subset of these vehicles and engines. EISA section 103(a)(3) defines a 'commercial medium- and heavy-duty on-highway vehicle' as an on-highway vehicle with GVWR of 10,000 pounds or more.[34] EISA section 103(a)(6) defines a 'work truck' as a vehicle that is rated at between 8,500 and 10,000 pounds gross vehicle weight and is not a medium-duty passenger vehicle.[35] Therefore, the term "heavy-duty trucks" in this proposal refers to both work trucks and commercial medium- and heavy-duty on-highway vehicles as defined by EISA. Heavy-duty engines affected by the proposed standards are those that are installed in commercial medium- and heavy-duty trucks, except for the engines installed in vehicles certified to a complete vehicle emissions standard based on a chassis test, which would be addressed as a part of those complete vehicles, and except for engines used exclusively for stationary power when the vehicle is parked. The agencies' scope is the same with the exception of recreational vehicles (or motor homes), as discussed above. EPA is proposing to include recreational on-highway vehicles within their rulemaking, while NHTSA is limiting their scope to commercial trucks which would not include these vehicles.

EPA and NHTSA are proposing standards for each of the following categories, which together comprise all heavy-duty vehicles and all engines used in such vehicles.[36] In order to most appropriately regulate the broad range of heavy-duty vehicles, the agencies are proposing to set separate engine and vehicle standards for the combination tractors and the Class 2b through 8 vocational vehicles and the engines installed in them. The engine standards and test procedures for engines installed in the tractors and vocational vehicles are discussed within the applicable vehicle sections.

- Class 7 and 8 Combination Tractors.
- Heavy-Duty Pickup Trucks and Vans.
- Class 2b through 8 Vocational Vehicles.

As discussed in Section IX, the agencies are not proposing GHG emission and fuel consumption standards for trailers at this time. In addition, the agencies are proposing to not set standards at this time for engine, chassis, and vehicle manufacturers which are small businesses (as defined). More detailed discussion of each regulatory category is included in the subsequent sections below.

B. Class 7 and 8 Combination Tractors

EPA is proposing CO_2 standards and NHTSA is proposing fuel consumption standards for new Class 7 and 8 combination tractors. The standards are for the tractor cab, with a separate standard for the engines that are installed in the tractor. Together these standards would achieve reductions up to 20 percent from tractors. As discussed below, EPA is proposing to adopt the existing useful life definitions for heavy-duty engines for the Class 7 and 8 tractors. NHTSA is proposing fuel consumption standards for tractors, and engine standards for heavy-duty engines for Class 7 and 8 tractors. The agencies' analyses, as discussed briefly below and in more detail later in this preamble and in the draft RIA Chapter 2, show that these standards are appropriate and feasible under each agency's respective statutory authorities.

EPA is also proposing standards to control N_2O, CH_4, and HFC emissions from Class 7 and 8 combination tractors. The proposed heavy-duty engine standards for both N_2O and CH_4 and details of the standard are included in the discussion in Section II. The proposed air conditioning leakage standards applying to tractor manufacturers to address HFC emissions are included in Section II.

The agencies are proposing CO_2 emissions and fuel consumption standards for the combination tractors that will focus on reductions that can be achieved through improvements in the tractor (such as aerodynamics), tires, and other vehicle systems. The agencies are also proposing heavy-duty engine standards for CO_2 emissions and fuel consumption that would focus on potential technological improvements in fuel combustion and overall engine efficiency.

The agencies have analyzed the feasibility of achieving the CO_2 and fuel consumption standards, based on projections of what actions manufacturers are expected to take to reduce emissions and fuel consumption. EPA and NHTSA also present the estimated costs and benefits of the

[34] Codified at 49 U.S.C. 32901(a)(7).

[35] EISA Section 103(a)(6) is codified at 49 U.S.C. 32901(a)(19). EPA defines medium-duty passenger vehicles as any complete vehicle between 8,500 and 10,000 pounds GVWR designed primarily for the transportation of persons which meet the criteria outlined in 40 CFR 86.1803–01. The definition specifically excludes any vehicle that (1) Has a capacity of more than 12 persons total or, (2) is designed to accommodate more than 9 persons in seating rearward of the driver's seat or, (3) has a cargo box (*e.g.,* pick-up box or bed) of six feet or more in interior length. (*See* the Tier 2 final rulemaking, 65 FR 6698, February 10, 2000.)

[36] Both agencies have authority to develop separate standards for vehicle and engine categories, as appropriate. *See* CAA section 202(a)(1) (authority to establish standards for "any class or classes of new motor vehicles or engines" and 49 U.S.C 32902(k)(2) (authority to establish standards for HD vehicles that are "appropriate, cost-effective, and technologically feasible" that are designed to achieve the "maximum feasible improvement" in fuel efficiency; authority to establish "separate standards for different classes of vehicles under this subsection." NHTSA interprets 49 U.S.C. 32902(k)(2) to include a grant of authority to establish engines standards pursuant to the broader statement of authority to establish standards that achieve the maximum feasible improvement in fuel efficiency.

standards in Section III. In developing the proposed rules, the agencies have evaluated the kinds of technologies that could be utilized by engine and tractor manufacturers, as well as the associated costs for the industry and fuel savings for the consumer and the magnitude of the CO_2 and fuel savings that may be achieved.

EPA and NHTSA are proposing attribute-based standards for the Class 7 and 8 combination tractors, or, put another way, we are proposing to set different standards for different subcategories of these tractors with the basis for subcategorization being particular tractor attributes. 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 consumer demand. There are several examples of where the agencies have utilized an attribute-based standard. In addition to the example of the recent light-duty vehicle fuel economy and GHG rule, in which the standards are based on the attribute of vehicle "footprint," the existing heavy-duty highway engine criteria pollutant emission standards for many years have been based on a vehicle weight attribute (Light Heavy, Medium Heavy, Heavy Heavy) with different useful life periods, which is the same approach proposed for the engine GHG and fuel consumption standards discussed below.

Heavy-duty combination tractors are built to move freight. The ability of a truck to meet a customer's freight transportation requirements depends on three major characteristics of the tractor: The gross vehicle weight rating (which along with gross combined weight rating (GCWR) establishes the maximum carrying capacity of the tractor and trailer), cab type (sleeper cabs provide overnight accommodations for drivers), and the tractor roof height (to mate tractors to trailers for the most fuel-efficient configuration). Each of these attributes impacts the baseline fuel consumption and GHG emissions, as well as the effectiveness of possible technologies, like aerodynamics, and is discussed in more detail below.

The first tractor characteristic to consider is payload which is determined by a tractor's GVWR and GCWR relative to the weight of the tractor, trailer, fuel, driver, and equipment. Class 7 trucks, which have a GVWR of 26,001–33,000 pounds and a typical GCWR of 65,000 pounds, have a lesser payload capacity than Class 8 trucks. Class 8 trucks have a GVWR of greater than 33,000 pounds and a typical 80,000 pound GCWR. Consistent with the recommendation in the National Academy of Sciences 2010 Report to NHTSA,[37] the agencies are proposing a load-specific fuel consumption metric (g/ton-mile and gal/1,000 ton-mile) where the "ton" represents the amount of payload. Generally, higher payload capacity trucks have better specific fuel consumption and GHG emissions than lower payload capacity trucks. Therefore, since the amount of payload that a Class 7 truck can carry is less than the Class 8 truck's payload capacity, the baseline fuel consumption and GHG emissions performance per ton-mile differs between the categories. It is consequently reasonable to distinguish between these two vehicle categories, so that the agencies are proposing separate standards for Class 7 and Class 8 tractors.

The agencies are not proposing to set a single standard for both Class 7 and 8 tractors based on the payload carrying capabilities and assumed typical payload levels of Class 8 tractors alone, as that would quite likely have the perverse impact of increasing fuel consumption and greenhouse gas emissions. Such a single standard would penalize Class 7 vehicles in favor of Class 8 vehicles. However, the greater capabilities of Class 8 tractors and their related greater efficiency when measured on a per ton-mile basis is only relevant in the context of operations where that greater capacity is needed. For many applications such as regional distribution, the trailer payloads dictated by the goods being carried are lower than the average Class 8 tractor payload. In those situations, Class 7 tractors are more efficient than Class 8 tractors when measured by ton-mile of actual freight carried. This is because the extra capabilities of Class 8 tractors add additional weight to vehicle that is only beneficial in the context of its higher capabilities. The existing market already selects for vehicle performance based on the projected payloads. By setting separate standards the agencies do not advantage or disadvantage Class 7 or 8 tractors relative to one another and continue to allow trucking fleets to purchase the vehicle most appropriate to their business practices.

The second characteristic that affects fuel consumption and GHG emissions is the relationship between the tractor cab roof height and the type of trailer used to carry the freight. The primary trailer types are box, flat bed, tanker, bulk carrier, chassis, and low boys. Tractor manufacturers sell tractors in three roof heights—low, mid, and high. The manufacturers do this to obtain the best aerodynamic performance of a tractor-trailer combination, resulting in reductions of GHG emissions and fuel consumption, because it allows the frontal area of the tractor to be similar in size to the frontal area of the trailer. In other words, high roof tractors are designed to be paired with a (relatively tall) box trailer while a low roof tractor is designed to pull a (relatively low) flat bed trailer. The baseline performance of a high roof, mid roof, and low roof tractor differs due to the variation in frontal area which determines the aerodynamic drag. For example, the frontal area of a low roof tractor is approximately 6 square meters, while a high roof tractor has a frontal area of approximately 9.8 square meters. Therefore, as explained below, the agencies are proposing that the roof height of the tractor determine the trailer type required to be used to demonstrate compliance of a truck with the fuel consumption and CO_2 emissions standards. As with vehicle weight classes, setting separate standards for each tractor roof height helps ensure that all tractors are regulated to achieve appropriate improvements, without inadvertently leading to increased emissions and fuel consumption by shifting the mix of vehicle roof heights offered in the market away from a level customarily tied to the actual trailers vehicles will haul in-use.

Tractor cabs typically can be divided into two configurations—day cabs and sleeper cabs. Line haul operations typically require overnight accommodations due to Federal Motor Carrier Safety Administration hours of operation requirements.[38] Therefore,

[37] *See* 2010 NAS Report, Note 19, Recommendation 2–1.

[38] The Federal Motor Carrier Safety Administration's Hours-of-Service regulations put limits in place for when and how long commercial motor vehicle drivers may drive. They are based on an exhaustive scientific review and are designed to ensure truck drivers get the necessary rest to perform safe operations. *See* 49 CFR part 395, and *see also http://www.fmcsa.dot.gov/rules-regulations/topics/hos/index.htm* (last accessed August 8, 2010).

some truck buyers purchase tractor cabs with sleeping accommodations, also known as sleeper cabs, because they do not return to their home base nightly. Sleeper cabs tend to have a greater empty curb weight than day cabs due to the larger cab volume and accommodations, which lead to a higher baseline fuel consumption for sleeper cabs when compared to day cabs. In addition, there are specific technologies, such as extended idle reduction technologies, which are appropriate only for tractors which hotel—such as sleeper cabs. To respect these differences, the agencies are proposing to create separate standards for sleeper cabs and day cabs.

To account for the relevant combinations of these attributes, the agencies therefore propose to segment combination tractors into the following nine regulatory subcategories:

- Class 7 Day Cab with Low Roof
- Class 7 Day Cab with Mid Roof
- Class 7 Day Cab with High Roof
- Class 8 Day Cab with Low Roof
- Class 8 Day Cab with Mid Roof
- Class 8 Day Cab with High Roof
- Class 8 Sleeper Cab with Low Roof
- Class 8 Sleeper Cab with Mid Roof
- Class 8 Sleeper Cab with High Roof

The agencies have not identified any Class 7 or Class 8 day cabs with mid roof heights in the market today but welcome comments with regard to this market characterization.

Adjustable roof fairings are used today on what the agencies consider to be low roof tractors. The adjustable fairings allow the operator to change the fairing height to better match the type of trailer that is being pulled which can reduce fuel consumption and GHG emissions during operation. The agencies propose to treat tractors with adjustable roof fairings as low roof tractors and test with the fairing down. The agencies welcome comments on this approach and data to support whether to allow additional credits for their use.

The agencies are proposing to classify all vehicles with sleeper cabs as tractors. The proposed rules would not allow vehicles with sleeper cabs to be classified as vocational vehicles. This provision is intended prevent the initial manufacture of straight truck vocational vehicles with sleeper cabs that, soon after introduction into commerce, would be converted to combination tractors, as a means to circumvent the Class 8 sleeper cab regulations. The agencies welcome comments on the likelihood of manufacturers using such an approach to circumvent the regulations and the appropriate regulatory provisions the agencies should consider to prevent such actions.

(1) What are the proposed Class 7 and 8 tractor and engine CO_2 emissions and fuel consumption standards and their timing?

In developing the proposed tractor and engine standards, the agencies have evaluated the current levels of emissions and fuel consumption, the kinds of technologies that could be utilized by truck and engine manufacturers to reduce emissions and fuel consumption from tractors and engines, the associated lead time, the associated costs for the industry, fuel savings for the consumer, and the magnitude of the CO_2 and fuel savings that may be achieved. The technologies that the agencies considered while setting the proposed tractor standards include improvements in aerodynamic design, lower rolling resistance tires, extended idle reduction technologies, and vehicle empty weight reduction. The technologies that the agencies considered while setting the engine standards include engine friction reduction, aftertreatment optimization, and turbocompounding, among others. The agencies' evaluation indicates that these technologies are available today, but have very low application rates in the market. The agencies have analyzed the technical feasibility of achieving the proposed CO_2 and fuel consumption standards for tractors and engines, based on projections of what actions manufacturers would be expected to take to reduce emissions and fuel consumption to achieve the standards. EPA and NHTSA also present the estimated costs and benefits of the Class 7 and 8 combination tractor and engine standards in Section III and in draft RIA Chapter 2.

(a) Tractor Standards

The agencies are proposing the following standards for Class 7 and 8 combination tractors in Table II–1, using the subcategorization approach just explained. As noted, the agencies are not aware of any mid roof day cab tractors at this time, but are proposing that any Class 7 and 8 day cabs with a mid roof would meet the respective low roof standards, based on the similarity in baseline performance and similarity in expected improvement of mid roof sleeper cabs relative to low roof sleeper cabs.

As explained below in Section III, EPA has determined that there is sufficient lead time to introduce various tractor and engine technologies into the fleet starting in the 2014 model year, and is proposing standards starting for that model year predicated on performance of those technologies. EPA is proposing more stringent tractor standards for the 2017 model year which reflect the CO_2 emissions reductions required through the 2017 model year engine standards. (As explained in Section II.B.(2)(h)(v) below, engine performance is one of the inputs into the proposed compliance model, and that input will change in 2017 to reflect the 2017 MY engine standards.) The 2017 MY vehicle standards are not premised on tractor manufacturers installing additional vehicle technologies. EPA's proposed standards apply throughout the useful life period as described in Section V. Similar to EPA's non-GHG standards approach, manufacturers may generate and use credits from Class 7 and 8 combination tractors to show compliance with the standards.

NHTSA is proposing Class 7 and 8 tractor fuel consumption standards that are voluntary standards in the 2014 and 2015 model years and become mandatory beginning in the 2016 model year, as required by the lead time and stability requirement within EISA. NHTSA is also proposing new standards for the 2017 model year which reflect additional improvements in only the heavy-duty engines. While NHTSA proposes to use useful life considerations for establishing fuel consumption performance for initial compliance and for ABT, NHTSA does not intend to implement an in-use compliance program for fuel consumption because it is not currently anticipated there will be notable deterioration of fuel consumption over the useful life. NHTSA believes that the vehicle and engine standards proposed for combination tractors are appropriate, cost-effective, and technologically feasible in the rulemaking timeframe based on our analysis detailed below in Section III and in the Chapter 2 of the draft RIA.

EPA and NHTSA are not proposing to make the 2017 vehicle standards more stringent based on the application of additional truck technologies because projected application rates of truck technologies used in setting the 2014 model year truck standard already reflect the maximum application rates we believe appropriate for these vehicles given their specific use patterns as described in Section III. We considered setting more stringent standards for Class 7 and 8 tractors based on the application of more advanced aerodynamic systems, such as self-compensating side extenders or other advanced aerodynamic technologies, but concluded that those technologies would not be fully developed in the necessary lead time. We request comment on this decision, supported by data as appropriate.

Table II-1: Heavy-duty Combination Tractor Emissions and Fuel Consumption Standards

2014 Model Year CO_2 Grams per Ton-Mile			
	Day Cab		Sleeper Cab
	Class 7	Class 8	Class 8
Low Roof	104	79	65
Mid Roof	104	79	70
High Roof	118	87	73
2014-2016 Model Year Gallons of Fuel per 1,000 Ton-Mile[39]			
	Day Cab		Sleeper Cab
	Class 7	Class 8	Class 8
Low Roof	10.3	7.8	6.3
Mid Roof	10.3	7.8	6.9
High Roof	11.6	8.6	7.1
2017 Model Year CO_2 Grams per Ton-Mile			
	Day Cab		Sleeper Cab
	Class 7	Class 8	Class 8
Low Roof	103	78	64
Mid Roof	103	78	69
High Roof	116	86	71
2017Model Year Gallons of Fuel per 1,000 Ton-Mile			
	Day Cab		Sleeper Cab
	Class 7	Class 8	Class 8
Low Roof	10.1	7.7	6.3
Mid Roof	10.1	7.7	6.8
High Roof	11.4	8.5	7.0

Based on our analysis, the 2017 model year standards represent up to a 20 percent reduction in CO_2 emissions and fuel consumption over a 2010 model year baseline, as detailed in Section III.A.2.

(i) Off-Road Tractor Standards

In developing the proposal EPA and NHTSA received comment from manufacturers and owners that tractors sometimes have very limited on-road usage. These trucks are defined to be motor vehicles under 40 CFR 85.1703, but they will spend the majority of their operations off-road. Tractors, such as those used in oil fields, will experience little benefit from improved aerodynamics and low rolling resistance tires. The agencies are therefore proposing to allow a narrow range of these de facto off-road trucks to be excluded from the proposed tractor standards because the trucks do not travel at speeds high enough to realize aerodynamic improvements and require special off-road tires such as lug tires. The trucks must still use a certified engine, which will provide fuel consumption and CO_2 emission reductions to the truck in all applications. To ensure the limited use of these trucks, the agencies are proposing requirements that the vehicles have off-road tires, have limited high speed operation, and are designed for specific off-road applications.[40] The agencies are proposing that a truck must meet the following requirements to qualify for an exemption from the vehicle standards for Class 7 and 8 tractors:

• Installed tires which are lug tires or contain a speed rating of less than or equal to 60 mph; and

• Include a vehicle speed limiter governed to 55 mph, and

• Contain Power Take-Off controls, or have axle configurations other than 4x2, 6x2, or 6x4 and has GVWR greater than 57,000 pounds; and

• Has a frame Resisting Bending Moment greater than 2,000,000 lb-in.[41]

EPA and NHTSA have concluded that the onroad performance losses and additional costs to develop a truck which meets these specifications will limit the exemption to trucks built for

[39] Manufacturers may voluntarily opt-in to the NHTSA fuel consumption program in 2014 or 2015. If a manufacturer opts-in, the program becomes mandatory. *See* Section [add cross reference] below for more information about NHTSA's voluntary opt-in program for MYs 2014 and 2015.

[40] For purposes of compliance with NHTSA's safety regulations, such as FMVSS Nos. 119 and 121, a manufacturer wishing for their vehicle to classify as "off-road" would still need to work with the relevant NHTSA office to declare its vehicle as "off-road" if it uses public roads at any point in its service.

[41] The agencies have found based on standard truck specifications, that vehicles designed for significant off-road applications, such as concrete pumper and logging trucks have resisting bending moment greater than 2,100,000 lb-in. (ranging up to 3,580,000 lb-in.). The typical on highway tractors have resisting bending moment of 1,390,000 lb-in.

the desired purposes.[42] The agencies welcome comment on the proposed requirements and exemptions.

(b) Engine Standards

EPA is proposing GHG standards and NHTSA is proposing fuel consumption standards for new heavy-duty engines. The standards will vary depending on the type of vehicle in which they are used, as well as whether the engines are diesel or gasoline powered. This section discusses the standards for engines used in Class 7 and 8 combination tractors and also provides some overall background information. More information is also provided in the discussion of the standards for engines used in vocational vehicles.

EPA's existing criteria pollutant emissions regulations for heavy-duty highway engines establish four regulatory categories that represent the engine's intended and primary truck application.[43] The Light Heavy-Duty (LHD) diesel engines are intended for application in Class 2b through Class 5 trucks (8,501 through 19,500 pounds GVWR). The Medium Heavy-Duty (MHD) diesel engines are intended for Class 6 and Class 7 trucks (19,501 through 33,000 pounds GVWR). The Heavy Heavy-Duty (HDD) diesel engines are primarily used in Class 8 trucks (33,001 pounds and greater GVWR). Lastly, spark ignition engines (primarily gasoline-powered engines) installed in incomplete vehicles less than 14,000 pounds GVWR and spark ignition engines that are installed in all vehicles (complete or incomplete) greater than 14,000 pounds GVWR are grouped into a single engine regulatory subcategory. The engines in these four regulatory subcategories range in size between approximately five liters and sixteen liters. The agencies welcome comments on updating the definitions of each subcategory, such as the typical horsepower levels, as described in 40 CFR 1036.140.

For the purposes of the GHG engine emissions and engine fuel consumption standards that EPA and NHTSA are proposing, the agencies intend to maintain these same four regulatory subcategories. This class structure would enable the agencies to set standards that appropriately reflect the technology available for engines for use in each type of vehicle, and that are therefore technologically feasible for these engines. This section discusses the MHD and HHD diesel engines used in Class 7 and 8 combination tractors. Additional details regarding the other heavy-duty engine standards are included in Section II.D.1.b.

EPA's proposed heavy-duty CO_2 emission standards for diesel engines installed in combination tractors are presented in Table II–2. We should note that this does not cover gasoline or LHDD engines as they are not used in Class 7 and 8 combination tractors. Similar to EPA's non-GHG standards approach, manufacturers may generate and use credits to show compliance with the standards. EPA is proposing to adopt the existing useful life definitions for heavy-duty engines. The EPA standards would become effective in the 2014 model year, with more stringent standards becoming effective in model year 2017. Recently, EPA's heavy-duty highway engine program for criteria pollutants provided new emissions standards for the industry in three year increments. Largely, the heavy-duty engine and truck manufacturer product plans have fallen into three year cycles to reflect this regulatory environment. The proposed two-step CO_2 emission standards recognize the opportunity for technology improvements over this timeframe while reflecting the typical diesel truck manufacturers' product plan cycles.

With respect to the lead time and cost of incorporating technology improvements that reduce GHG emissions and fuel consumption, EPA and NHTSA place important weight on the fact that during MYs 2014–2017 engine manufacturers are expected to redesign and upgrade their products. Over these four model years there will be an opportunity for manufacturers to evaluate almost every one of their engine models and add technology in a cost-effective way, consistent with existing redesign schedules, to control GHG emissions and reduce fuel consumption. The time-frame and levels for the standards, as well as the ability to average, bank and trade credits and carry a deficit forward for a limited time, are expected to provide manufacturers the time needed to incorporate technology that will achieve the proposed GHG and fuel consumption reductions, and to do this as part of the normal engine redesign process. This is an important aspect of the proposed rules, as it will avoid the much higher costs that would occur if manufacturers needed to add or change technology at times other than these scheduled redesigns. This time period will also provide manufacturers the opportunity to plan for compliance using a multi-year time frame, again in accord with their normal business practice. Further details on lead time, redesigns and technical feasibility can be found in Section III.

NHTSA's fuel consumption standards, also presented in Table II–2, would contain voluntary engine standards starting in 2014 model year, with mandatory engine standards starting in 2017 model year, harmonized with EPA's 2017 model year standards. A manufacturer may opt-in to NHTSA's voluntary standards in 2014, 2015 or 2016. Once a manufacturer opts-in, the standards become mandatory for the opt-in and subsequent model years, and the manufacturer may not reverse its decision. To opt into the program, a manufacturer must declare its intent to opt in to the program at the same time it submits the Pre-Certification Compliance Report. See 49 CFR 535.8 for information related to the Pre-Certification Compliance Report. A manufacturer opting into the program would begin tracking credits and debits beginning in the model year in which they opt into the program.

[42] The estimated cost for a lift axle is approximately $10,000. Axles with weight ratings greater than a typical on-road axle cost an additional $3,000.

[43] *See* 40 CFR 1036.140.

Table II-2: Proposed Heavy-duty Diesel Engine Standards for Engines Installed in Tractors

Effective 2014 Model Year		
	MHD Diesel Engine	HHD Diesel Engine
CO_2 Standard (g/bhp-hr)	502	475
Voluntary Fuel Consumption Standard (gallon/100 bhp-hr)	4.93	4.67
Effective 2017 Model Year		
	MHD Diesel Engine	HHD Diesel Engine
CO_2 Standard (g/bhp-hr)	487	460
Fuel Consumption (gallon/100 bhp-hr)	4.78	4.52

Combination tractors spend the majority of their operation at steady state conditions, and will obtain in-use benefit of technologies such as turbocompounding and other waste heat recovery technologies during this kind of typical engine operation. Therefore, the engines installed in tractors would be required to meet the standard based on the steady-state SET test cycle, as discussed further in Section II.B(2)(i).

The baseline HHD diesel engine performance in 2010 model year on the SET is 490 g CO_2/bhp-hr (4.81 gal/100 bhp-hr), as determined from confidential data provided by manufacturers and data submitted for the non-GHG emissions certification process. Similarly, the baseline MHD diesel engine performance on the SET cycle is 518 g CO_2/bhp-hr (5.09 gallon/100-bhp-hr) in the 2010 model year. Further discussion of the derivation of the baseline can be found in Section III The diesel engine standards that EPA is proposing and the voluntary standards being proposed by NHTSA for the 2014 model year would require diesel engine manufacturers to achieve on average a three percent reduction in fuel consumption and CO_2 emissions over the baseline 2010 model year performance for the engines. The agencies' assessment of the findings of the 2010 NAS Report and other literature sources indicates that there are technologies available to reduce fuel consumption by this level in the proposed timeframe. These technologies include improved turbochargers, aftertreatment optimization, low temperature exhaust gas recirculation, and engine friction reductions. Additional discussion on technical feasibility is included in Section III below and in draft RIA Chapter 2.

Furthermore, the agencies are proposing that diesel engines further reduce fuel consumption and CO_2 emissions from the 2010 model year baseline in 2017 model year. The proposed reductions represent on average a six percent reduction for MHD and HHD diesel engines required to use the SET-based standard. The additional reductions could likely be achieved through the increased refinement of the technologies projected to be implemented for 2014, plus the addition of turbocompounding or other waste heat recovery systems. The agencies' analysis indicates that this type of advanced engine technology would require a longer development time than the 2014 model year, and we therefore are proposing to provide additional lead time to allow for its introduction.

The agencies are aware that some truck and engine manufacturers would prefer to align their product development plans for these engine standards with their current plans to meet Onboard Diagnostic regulations for EPA and California in 2013 and 2016. We believe our proposed averaging, banking and trading provisions already provide these manufacturers with considerable flexibility to manage their GHG compliance plans consistent with the 2013 model year. Nevertheless, we are requesting comment on whether EPA and NHTSA should provide additional defined phase-in schedules that would more explicitly accommodate this request. For example, we request comment on a phase-in schedule with a standard of 485 g/bhp-hr for the model years 2013–2015 followed by a standard of 460 g/bhp-hr for 2016–18 model years with the associated fuel consumption values for the NHTSA program. This phase-in schedule is just one of many potential schedules that would provide identical fuel savings and emissions reductions for the period from 2013–2018. If commenters wish to discuss a different phase-in schedule than the one proposed by the agencies, we request that commenters include a description of their preferred phase-in schedule, including an analysis showing that it would be at least as effective (or more) as the primary program for the period through the 2018 model year. We also request comment on whether similar provisions should be made for the vocational engine standards discussed later in this section.

In proposing this standard for heavy-duty diesel engines used in Class 7 and 8 combination tractors, the agencies have examined the current performance levels of the engines across the fleet. EPA and NHTSA found that a large majority of the engines were generally relatively close to the average baseline, with some above and some below. We recognize, however, that when regulating a category of engines for the first time, there will be individual products that may deviate significantly from this baseline level of performance. For the current fleet there is a relatively small group of engines that are significantly worse than the average baseline for other engines. In proposing the standards, the agencies have looked primarily at the typical performance levels of the majority of the engines in the fleet, and the increased performance that would be achieved through increased spread of technology. The agencies also recognize that for the smaller group of products, the same reduction from the industry baseline may experience significant issues of available lead-time and cost because these products may require a total redesign in order to meet the standards. These are limited instances where certain engine families have high atypically high baseline CO_2 levels and limited line of engines across which to average performance. *See* 75 FR 25414–25419, which adopts temporary lead time allowance alternative standards to deal with a similar issue for a subset of light-duty vehicles. To accommodate these situations, the agencies are proposing a regulatory alternative whereby a manufacturer, for a limited period, would have the option to comply with a unique standard based on a three percent reduction from an individual engine's own 2011 model year baseline level, rather than meeting the otherwise-applicable standard level. Our assessment is that this three percent reduction is appropriate given the potential for manufacturers to apply similar technology packages with similar cost to what we have estimated for the primary program. We do not believe this alternative needs to continue past the 2016 model year since manufacturers will have had ample opportunity to benchmark competitive products during redesign cycles and to make appropriate changes to bring their product performance into line with the rest of the industry. This alternative would not be available unless and until a manufacturer had exhausted all available credits and credit opportunities, and engines under the alternative standard could not generate credits. We are proposing that manufacturers can select engine families for this alternative standard without agency approval, but are proposing to require that manufacturers notify the agency of their choice and to include in that notification a demonstration that it has exhausted all available credits and credit opportunities.

The agencies are also requesting comment on the potential to extend this regulatory alternative for one additional year for a single engine family with performance measured in that year as six percent beyond the engine's own 2011 baseline level. We also request comment on the level of reduction beyond the baseline that is appropriate in this alternative. The three percent level reflects the aggregate improvement beyond the baseline we are requiring of the entire industry. As this provision is intended to address potential issues for legacy products that we would expect to be replaced or significantly improved at the manufacturer's next product redesign, we request comment if a two percent reduction would be more appropriate. We would consider two percent rather than three percent if we were convinced that making all of the changes we have outlined in our assessment of the technical feasibility of the standards was not possible for some engines due to legacy design issues that will change in the future. We are proposing that manufacturers making use of these provisions would need to exhaust all credits within this subcategory prior to using this flexibility and would not be able to generate emissions credits from other engines in the same regulatory subcategory as the engines complying using this alternate approach.

EPA and NHTSA considered setting even more stringent engine standards for the 2017 model year based on the use of more sophisticated waste heat recovery technologies such as bottoming cycle engine designs. We are not proposing more stringent standards because we do not believe this technology can be broadly available by 2017 model year. We request comment on the technological feasibility and cost-effectiveness of more stringent standards in the timeframe of the proposed standards.

(c) 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. The in-use standards that EPA is proposing would apply to individual vehicles and engines. NHTSA is not proposing to adopt in-use.

EPA is proposing that the in-use standards for heavy-duty engines installed in tractors be established by adding an adjustment factor to the full useful life emissions and fuel consumption results projected in the EPA certification process. EPA is proposing a 2 percent adjustment factor for the in-use standard to provide a reasonable margin for production and test-to-test variability that could result in differences between the initial emission test results and emission results obtained during subsequent in-use testing. Details on the development of the adjustment factor are included in draft RIA Chapter 3.

EPA is also proposing that the useful life for these engine and vehicles with respect to GHG emissions be set equal to the respective useful life periods for criteria pollutants. EPA proposes that the existing engine useful life periods, as included in Table II–3:, be broadened to include CO_2 emissions and fuel consumption for both engines and tractors (*see* 40 CFR 86.004–2).

Table II-3: Tractor and Engine Useful Life Periods

	Years	Miles
Medium Heavy-Duty Diesel Engines and Class 7 Tractors	10	185,000
Heavy Heavy-Duty Diesel Engines and Class 8 Tractors	10	435,000

EPA and NHTSA request comments on the magnitude and need for an in-use adjustment factor for the engine standard and the compliance model (GEM) based tractor standard.

(2) Test Procedures and Related Issues

The agencies are proposing a complete set of test procedures to evaluate fuel consumption and CO_2 emissions from Class 7 and 8 tractors and the engines installed in them. The test procedures related to the tractors are all new, while the engine test procedures build substantially on EPA's current non-GHG emissions test procedures, except as noted. This section discusses the proposed simulation model developed for demonstrating compliance with the tractor standard and the proposed engine test procedures.

(a) Truck Simulation Model

We are proposing to set separate engine and vehicle-based emission standards to achieve the goal of reducing emissions and fuel consumption for both trucks and engines. For the Class 7 and 8 tractors, engine manufacturers would be subject to the engine standards, and Class 7 and 8 tractor manufacturers would be required to install engines in their tractors certified for use in the tractor. The tractor manufacturer would be subject to a separate vehicle-based standard that would use a proposed truck simulation model to evaluate the impact of the tractor cab design to determine compliance with the tractor standard.

A simulation model, in general, uses various inputs to characterize a vehicle's properties (such as weight, aerodynamics, and rolling resistance) and predicts how the vehicle would behave on the road when it follows a driving cycle (vehicle speed versus time). On a second-by-second basis, the model determines how much engine power needs to be generated for the vehicle to follow the driving cycle as closely as possible. The engine power is then transmitted to the wheels through transmission, driveline, and axles to move the vehicle according to the driving cycle. The second-by-second fuel consumption of the vehicle, which corresponds to the engine power demand to move the vehicle, is then calculated according to a fuel consumption map in the model. Similar to a chassis dynamometer test, the second-by-second fuel consumption is aggregated over the complete drive cycle to determine the fuel consumption of the vehicle.

NHTSA and EPA are proposing to evaluate fuel consumption and CO_2 emissions respectively through a simulation of whole-vehicle operation, consistent with the NAS recommendation to use a truck model to evaluate truck performance. The agencies developed the Greenhouse gas Emissions Model (GEM) for the specific purpose of this proposal to evaluate truck performance. The GEM is similar in concept to a number of vehicle simulation tools developed by commercial and government entities. The model developed by the agencies and proposed here was designed for the express purpose of vehicle compliance demonstration and is therefore simpler and less configurable than similar commercial products. This approach gives a compact and quicker tool for vehicle compliance without the overhead and costs of a more sophisticated model. Details of the model are included in Chapter 4 of the draft RIA. The agencies are aware of several other simulation tools developed by universities and private companies. Tools such as Argonne National Laboratory's Autonomie, Gamma Technologies' GT–Drive, AVL's CRUISE, Ricardo's VSIM, Dassault's DYMOLA, and University of Michigan's HE–VESIM codes are publicly available. In addition, manufacturers of engines, vehicles, and trucks often have their own in-house simulation tools. The agencies welcome comments on other simulation tools which could be used by the agencies. The use criteria for this model are that it must be able to be managed by the agencies for compliance purposes, has no cost to the end-user, is freely available and distributable as an executable file, contains open source code to provide transparency in the model's operation yet contains features which cannot be changed by the user, and is easy to use by any user with minimal or no prior experience.

GEM is designed to focus on the inputs most closely associated with fuel consumption and CO_2 emissions—*i.e.,* on those which have the largest impacts such as aerodynamics, rolling resistance, weight, and others.

EPA has validated GEM based on the chassis test results from a SmartWay certified tractor tested at Southwest Research Institute. The validation work conducted on these three vehicles is representative of the other Class 7 and 8 tractors. Many aspects of one tractor configuration (such as the engine, transmission, axle configuration, tire sizes, and control systems) are similar to those used on the manufacturer's sister models. For example, the powertrain configuration of a sleeper cab with any roof height is similar to the one used on a day cab with any roof height. Overall, the GEM predicted the fuel consumption and CO_2 emissions within 4 percent of the chassis test procedure results for three test cycles—the California ARB Transient cycle, 65 mph cruise cycle, and 55 mph cruise cycle. These cycles are the ones the agencies are proposing to utilize in compliance testing. Test to test variation for heavy-duty vehicle chassis testing can be higher than 4 percent based on driver variation. The proposed simulation model is described in greater detail in Chapter 4 of the draft RIA and is available for download by interested parties at (*http://www.epa.gov/otaq/climate/regulations.htm*). We request comment on all aspects of this approach to compliance determination in general and to the use of the GEM in particular.

The agencies are proposing that for demonstrating compliance, a Class 7 and 8 tractor manufacturer would measure the performance of specified tractor systems (such as aerodynamics and tire rolling resistance), input the values into GEM, and compare the model's output to the standard. The agencies propose that a tractor manufacturer would provide the inputs for each of following factors for each of the tractors it wished to certify under CO_2 standards and for establishing fuel consumption values: Coefficient of Drag, Tire Rolling Resistance Coefficient, Weight Reduction, Vehicle Speed Limiter, and Extended Idle Reduction Technology. These are the technologies on which the agencies' own feasibility analysis for these vehicles is predicated. An example of the GEM input screen is included in Figure II–3.

The input values for the simulation model would be derived by the manufacturer from test procedures proposed by the agencies in this proposal. The agencies are proposing several testing alternatives for aerodynamic assessment, a single procedure for tire rolling resistance coefficient determination, and a prescribed method to determine tractor weight reduction. The agencies are proposing defined model inputs for determining vehicle speed limiter and extended idle reduction technology benefits. The other aspects of vehicle performance are fixed within the model as defined by the agencies and are not varied for the purpose of compliance.

(b) Metric

Test metrics which are quantifiable and meaningful are critical for a regulatory program. The CO_2 and fuel consumption metric should reflect what we wish to control (CO_2 or fuel consumption) relative to the clearest value of its use: In this case, carrying freight. It should encourage efficiency improvements that will lead to reductions in emissions and fuel consumption during real world operation. The agencies are proposing standards for Class 7 and 8 combination tractors that would be expressed in terms of moving a ton (2000 pounds) of freight over one mile. Thus, NHTSA's proposed fuel consumption standards for these trucks would be represented as gallons of fuel used to move one ton of freight 1,000 miles, or gal/1,000 ton-mile. EPA's proposed CO_2 vehicle standards would be represented as grams of CO_2 per ton-mile.

Similarly, the NAS panel concluded, in their report, that a load-specific fuel consumption metric is appropriate for HD trucks. The panel spent considerable time explaining the advantages of and recommending a load-specific fuel consumption approach to regulating the fuel efficiency of heavy-duty trucks. *See* NAS Report pages 20 through 28. The panel first points out that the nonlinear relationship between fuel economy and fuel consumption has led consumers of light-duty vehicles to have difficulty in judging the benefits of replacing the most inefficient vehicles. The panel describes an example where a light-duty vehicle can save the same 107 gallons per year (assuming 12,000 miles travelled per year) by improving one vehicle's fuel efficiency from 14 to 16 mpg or improving another vehicle's fuel efficiency from 35 to 50.8 mpg. The use of miles per gallon leads consumers to undervalue the importance of small mpg improvements in vehicles with lower fuel economy. Therefore, the NAS panel recommends the use of a fuel consumption metric over a fuel economy metric. The panel also describes the primary purpose of most heavy-duty vehicles as moving freight or passengers (the payload). Therefore, they concluded that the most appropriate way to represent an attribute-based fuel consumption metric is to normalize the fuel consumption to the payload.

With the approach to compliance NHTSA and EPA are proposing, a default payload is specified for each of the tractor categories suggesting that a gram per mile metric with a specified payload and a gram per ton-mile metric would be effectively equivalent. The primary difference between the metrics and approaches relates to our treatment of mass reductions as a means to reduce fuel consumption and greenhouse gas emissions. In the case of a gram per mile metric, mass reductions are reflected only in the calculation of the work necessary to move the vehicle mass through the drive cycle. As such it directly reduces the gram emissions in the numerator since a vehicle with less mass will require less energy to move through the drive cycle leading to lower CO_2 emissions. In the case of Class 7 and 8 tractors and our proposed gram/ton-mile metric, reductions in mass are reflected both in less mass moved through the drive cycle (the numerator) and greater payload (the denominator). We adjust the payload based on vehicle mass reductions because we estimate that approximately one third of the time the amount of freight loaded in a trailer is limited not by volume in the trailer but by the total gross vehicle weight rating of the tractor. By reducing the mass of the tractor the mass of the freight loaded in the tractor can go up. Based on this general approach, it can be estimated that for every 1,200 pounds in mass reduction total truck vehicle miles traveled and therefore trucks on the road could be reduced by one percent. Without the use of a per ton-mile metric it would not be clear or straightforward for the agencies to reflect the benefits of mass reduction from large freight carrying vehicles that are often limited in the freight they carry by the gross vehicle weight rating of the truck. The agencies seek comment on the use of a per ton-mile metric and also whether other metrics such as per cube-mile should be considered instead.

(c) Truck Aerodynamic Assessment

The aerodynamic drag of a vehicle is determined by the vehicle's coefficient of drag (Cd), frontal area, air density and speed. The agencies are proposing to establish and use pre-defined values for the input parameters to GEM which represent the frontal area and air density, while the speed of the vehicle would be determined in GEM through the proposed drive cycles. The agencies are proposing that the manufacturer would determine a truck's Cd, a dimensionless measure of a vehicle's aerodynamics, for input into the model through a combination of vehicle testing and vehicle design characteristics. Quantifying truck aerodynamics as an input to the GEM presents technical challenges because of the proliferation of truck configurations, the lack of a clearly preferable standardized test method, and subtle variations in measured Cd values among various test procedures. Class 7 and 8 tractor aerodynamics are currently developed by manufacturers using a range of techniques, including vehicle coastdown testing, wind tunnel testing, computational fluid dynamics, and constant speed tests as further discussed below. Reflecting that each of these approaches has limitations and no one approach appears to be superior to others, the agencies are proposing to allow all three aerodynamic evaluation methods to be used in demonstrating a vehicle's aerodynamic performance. The agencies welcome comments on each of these methods.

The agencies are proposing that the coefficient of drag assessment be a product of test data and vehicle characteristics using good engineering judgment. The primary tool the agencies expect to use in our own evaluation of aerodynamic performance is the coastdown procedure described in SAE Recommended Practice J2263. Allowing manufacturers to use multiple test procedures and modeling coupled with good engineering judgment to determine aerodynamic performance is consistent with the current approach used in determining representative road load forces for light-duty vehicle testing (40 CFR 86.129–00(e)(1)). The agencies anticipate that as we and the industry gain experience with assessing aerodynamic performance of HD vehicles for purposes of compliance a test-only approach may have advantages.

We believe this broad approach allowing manufacturers to use multiple different test procedures to demonstrate aerodynamic performance 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 accomplish this, the agencies propose to use a two-part approach that evaluates aerodynamic performance not only through testing but through the application of good engineering judgment and a technical description of the vehicles aerodynamic characteristics. The first part of the proposed evaluation approach uses a bin structure characterizing the expected aerodynamic performance of tractors based on definable vehicle attributes. This bin approach is described further below. The second proposed evaluation element uses aerodynamic testing to measure the vehicle's aerodynamic performance under standardized conditions. The agencies expect that the SAE J2263 coastdown procedures will be the primary aerodynamic testing tool but are interested in working with the regulated industry and other interested stakeholders to develop a primary test approach. Additionally, the agencies propose to have a process that would allow manufacturers to demonstrate that another aerodynamic test procedure should also be allowed for purposes of generating inputs used in assessing a truck's performance. We are requesting comment on methods that should form the primary aerodynamic testing tool, methods that may be appropriate as alternatives, and the mechanism (including standards, practices, and unique criteria) for the agencies to consider allowing alternative aerodynamic test methods.

NHTSA and EPA are proposing that manufacturers use a two part screening approach for determining the aerodynamic inputs to the GEM. The first part would require the manufacturers to assign each vehicle aerodynamic configuration to one of five aerodynamics bins created by EPA and NHTSA as described below. The assignment by bin reflects the aerodynamic characteristics of the vehicle. For each bin, EPA and NHTSA have already defined a nominal Cd that will be used in the GEM and a range of Cd values that would be expected from testing of vehicles meeting this bin description. The second part would require the manufacturer to then compare its own test results of aerodynamic performance (as conducted in accordance with the agencies' requirements) for the vehicle to confirm the actual aerodynamic performance was consistent with the agencies' expectations for vehicles within this bin. If the predicted performance and actual observed performance match, the Cd value as an input for the GEM is the nominal Cd value defined for the bin. If, however, a manufacturer's test data demonstrates performance that is better than projected for the assigned bin a manufacturer may use the test data and good engineering judgment to demonstrate to the agencies that this particular vehicle's performance is in keeping with the performance level of a more aerodynamic bin and with the agencies' permission may use the Cd value of the more aerodynamic bin. Conversely, if the test data demonstrates that the performance is worse than the projected bin, then the manufacturer would use the Cd value from the less aerodynamic bin. Using this approach, the bin structure can be seen as the agencies' first effort to create a common measure of aerodynamic performance to benchmark the various test methods manufacturers may use to demonstrate aerodynamic performance. For example, if a manufacturer's test methods consistently produce Cd values that are better than projected by the agencies, EPA and NHTSA can use this information to further scrutinize the manufacturer's test procedure, helping to ensure that all manufacturers are competing on a level playing field.

The agencies are proposing aerodynamic technology bins which divide the wide spectrum of tractor aerodynamics into five bins (*i.e.,* categories). The first category, "Classic," represents tractor bodies which prioritize appearance or special duty capabilities over aerodynamics. The Classic trucks incorporate few, if any, aerodynamic features and may have several features which detract from aerodynamics, such as bug deflectors, custom sunshades, B-pillar exhaust stacks, and others. The second category for aerodynamics is the "Conventional" tractor body. The agencies consider Conventional tractors to be the average new tractor today which capitalizes on a generally aerodynamic shape and avoids classic features which increase drag. Tractors within the "SmartWay" category build on Conventional tractors with added components to reduce drag in the most significant areas on the tractor, such as fully enclosed roof fairings, side extending gap reducers, fuel tank fairings, and streamlined grill/hood/mirrors/bumpers. The "Advanced SmartWay" aerodynamic category builds upon the SmartWay tractor body with additional aerodynamic treatments such as underbody airflow treatment, down exhaust, and lowered ride height, among other technologies. And finally, "Advanced SmartWay II" 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. The agencies recognize that these proposed aerodynamic bins are static and referential and that there may be other technologies that may provide similar aerodynamic benefit. In addition, it is expected that aerodynamic equipment will advance over time and the agencies may find it appropriate and necessary to revise the bin descriptions.

Under this proposal, the manufacturer would then input into GEM the Cd value specified for each bin as also defined in Table II–4. For example, if a manufacturer tests a Class 8 sleeper cab high roof tractor with features which are similar to a SmartWay tractor and the test produces a Cd value of 0.59, then the manufacturer would assign this tractor to the Class 8 Sleeper Cab High Roof SmartWay bin. The manufacturer would then use the Cd value of 0.60 as the input to GEM.

Table II-4: Aerodynamic Input Definitions to GEM

	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
Aerodynamics Test Results (Cd)							
Classic	≥0.83	≥0.73	≥0.83	≥0.73	≥0.83	≥0.78	≥0.73
Conventional	0.78-0.82	0.63-0.72	0.78-0.82	0.63-0.72	0.78-0.82	0.73-0.77	0.63-0.72
SmartWay	0.73-0.77	0.58-0.62	0.73-0.77	0.58-0.62	0.73-0.77	0.68-0.72	0.58-0.62
Advanced SmartWay	0.68-0.72	0.53-0.57	0.68-0.72	0.53-0.57	0.68-0.72	0.63-0.67	0.53-0.57
Advanced SmartWay II	≤0.67	≤0.52	≤0.67	≤0.52	≤0.67	≤0.62	≤0.52
Aerodynamic Input to GEM (Cd)							
Frontal Area (m^2)	6.0	9.8	6.0	9.8	6.0	7.7	9.8
Classic	0.85	0.75	0.85	0.75	0.85	0.80	0.75
Conventional	0.80	0.68	0.80	0.68	0.80	0.75	0.68
SmartWay	0.75	0.60	0.75	0.60	0.75	0.70	0.60
Advanced SmartWay	0.70	0.55	0.70	0.55	0.70	0.65	0.55
Advanced SmartWay II	0.65	0.50	0.65	0.50	0.65	0.60	0.50

Coefficient of drag and frontal area of the tractor-trailer combination go hand-in-hand to determine the force required to overcome aerodynamic drag. As explained above, the agencies are proposing that the Cd value is one of the GEM inputs which will be derived by the manufacturer. However, the agencies are proposing to specify the truck's frontal area for each regulatory category (i.e., each of the seven subcategories which are proposed and listed in Table II–4 under the Aerodynamic Input to GEM). The frontal area of a high roof tractor pulling a box trailer will be determined primarily by the box trailer's dimensions and the ground clearance of the tractor. The frontal area of low and mid roof tractors will be determined by the tractor itself. An alternate approach to the proposed frontal area specification is to create the aerodynamic input table (as shown in Table II–4) with values that represent the Cd multiplied by the frontal area. This approach will provide the same aerodynamic load, but it will not allow the comparison of aerodynamic efficiency across regulatory categories that can be done with the Cd values alone. The agencies are interested in comments regarding the frontal area of trucks, specifically whether the specified frontal areas are appropriate and whether the use of standard frontal areas may have unanticipated consequences.

EPA and NHTSA recognize 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. As noted in the NAS report,[44] the wind average drag coefficient is about 15 percent higher than the zero degree coefficient of drag. The agencies considered proposing the use of a wind averaged drag coefficient in this regulatory program, but ultimately decided to propose using coefficient of drag values which represent zero yaw (*i.e.*, representing wind from directly in front of the vehicle, not from the side) instead. We are taking this approach recognizing that wind tunnels are currently the only tool to accurately assess the influence of wind speed and direction on a truck's aerodynamic performance. The agencies recognize, 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. We believe this approach will not impact technology effectiveness or change the kinds of technology decisions made by the tractor manufacturers in developing equipment to meet our proposed standards. However, the agencies are interested in receiving comment on approaches to develop wind averaged coefficient of drag values using computational fluid dynamics, coastdown, and constant speed test procedures.

The methodologies the agencies are considering for aerodynamic assessment include coastdown testing, wind tunnel testing, computational fluid dynamics, and constant speed testing. The agencies welcome information on a constant speed test procedure and how it could be applied to determine aerodynamic drag. In addition, the agencies seek comment on allowing multiple aerodynamic assessment methodologies and the need for comparison of aerodynamic assessment methods to determine method precision and accuracy.

(i) Coastdown Testing

The coastdown test procedure has been used extensively in the light-duty industry to capture the road load force by coasting a vehicle along a flat straightaway under a set of prescribed conditions. Coast down testing has been used less extensively to obtain road load forces for medium- and heavy-duty vehicles. EPA has conducted a significant amount of test work to demonstrate that coastdown testing per SAE J2263 produces reasonably repeatable test results for Class 7 and 8 tractor/trailer pairings, as described in draft RIA Chapter 3. The agencies propose that a manufacturer which chooses this method would determine a tractor's Cd value through analysis of the road load force equation derived from SAE J2263 Revised 2008–12 test results, as proposed in 40 CFR 1066.210.

(ii) Wind Tunnel Testing

A wind tunnel provides a stable environment yielding a more repeatable test than coastdown. This allows the manufacturer to run multiple baseline vehicle tests and explore configuration modifications for nearly the same effort (*e.g.,* time and cost) as conducting the coastdown procedure. In addition, wind tunnels provide testers with the ability to yaw the vehicle at positive and negative angles relative to the original centerline of the vehicle to accurately capture the influence of non-uniform wind direction on the Cd (*e.g.,* wind averaged Cd).

The agencies propose to allow the use of existing wind tunnel procedures adopted by SAE International with some minor modifications as discussed in Section V of this proposal. The agencies seek comments on the appropriateness of using the existing SAE wind tunnel procedures, and the modifications to these procedures, for this regulatory purpose.

(iii) Computational Fluid Dynamics

Computational fluid dynamics, or CFD, capitalizes on today's computing power by modeling a full size vehicle and simulating the flows around this model to examine the fluid dynamic properties, in a virtual environment. CFD tools are used to solve either the Navier-Stokes equations that relate the physical law of conservation of momentum to the flow relationship around a body in motion or a static body with fluid in motion around it, or the Boltzman equation that examines fluid mechanics and determines the characteristics of discreet, individual particles within a fluid and relates this behavior to the overall dynamics and behavior of the fluid. CFD analysis involves several steps: Defining the model structure or geometry based on provided specifications to define the basic model shape; applying a closed surface around the structure to define the external model shape (wrapping or surface meshing); dividing the control volume, including the model and the surrounding environment, up into smaller, discreet shapes (gridding); defining the flow conditions in and out of the control volume and the flow relationships within the grid (including eddies and turbulence); and solving the flow equations based on the prescribed flow conditions and relationships.

This approach can be beneficial to manufacturers since they can rapidly prototype (*e.g.,* design, research, and model) an entire vehicle without investing in material costs; they can modify and investigate changes easily; and the data files can be re-used and shared within the company or with corporate partners.

The accuracy of the outputs from CFD analysis is highly dependent on the inputs. The CFD modeler decides what method to use for wrapping, how fine the mesh cell and grid size should be, and the physical and flow relationships within the environment. A balance must be achieved between the number of cells, which defines how fine the mesh is, and the computational times for a result (*i.e.,* solution-time-efficiency). All of these decisions affect the results of the CFD aerodynamic assessment.

[44] *See* 2010 NAS Report, Note 19, Finding 2–4 on page 39.

Because CFD modeling is dependent on the quality of the data input and the design of the model, the agencies propose and seek comment on a minimum set of criteria applicable to using CFD for aerodynamic assessment in Section V.

(d) Tire Rolling Resistance Assessment

NHTSA and EPA are proposing that the tractor's tire rolling resistance input to the GEM be determined by either the tire manufacturer or tractor manufacturer using the test method adopted by the International Organization for Standardization, ISO 28580:2009.[45] The agencies believe the ISO test procedure is appropriate to propose for this program because the procedure is the same one used by NHTSA in its fuel efficiency tire labeling program[46] and is consistent with the direction being taken by the tire industry both in the United States and Europe. The rolling resistance from this test would be used to specify the rolling resistance of each tire on the steer and drive axle of the vehicle. The results would be expressed as a rolling resistance coefficient and measured as kilogram per metric ton (kg/metric ton). The agencies are proposing that three tire samples within each tire model be tested three times each to account for some of the production variability and the average of the nine tests would be the rolling resistance coefficient for the tire. The GEM would use a combined tire rolling resistance, where 15 percent of the gross weight of the truck and trailer would be distributed to the steer axle, 42.5 percent to the drive axles, and 42.5 percent to the trailer axles.[47] The trailer tires' rolling resistance would be prescribed by the agencies as part of the standardized trailer used for demonstrating compliance at 6 kg/metric ton, which was the average trailer tire rolling resistance measured during the SmartWay tire testing.[48]

We acknowledge that the useful life of original equipment tires used on tractors is shorter than the tractor's useful life. In this proposal, we are treating the tires as if the owner replaces the tire with tires that match the original equipment. Some owners opt for the original tires under the assumption that this is the best product. However, tractor tires are often retreaded or replaced. Steer tires on a highway tractor might need replacement after 75,000 to 150,000 miles. Drive tires might need retreading or replacement after 150,000 to 300,000 miles. Of course, tire removal miles can be much higher or lower, depending upon a number of factors that affect tire removal miles. These include the original tread depth; desired tread depth at removal to maintain casing integrity; tire material and construction; typical load; tire "scrub" due to urban driving and set back axles; and, tire under-inflation. Since it is common for both medium- and heavy-duty truck tires to be replaced and retreaded, we welcome comments in this area. We are specifically seeking data for the rolling resistance of retread and replacement heavy-duty tires and the typical useful life of tractor tires.

(e) Weight Reduction Assessment

EPA and NHTSA are seeking to account for the emissions and fuel consumption benefits of weight reduction as a control technology in heavy-duty trucks. Weight reduction impacts the emissions and fuel consumption performance of tractors in different ways depending on the truck's operation. For trucks that cube-out, the weight reduction will show a small reduction in grams of CO_2 emitted or fuel consumed per mile travelled. The benefit is small because the weight reduction is minor compared to the overall weight of the combination tractor and payload. However, a weight reduction in tractors which operate at maximum gross vehicle weight rating would result in an increase in payload capacity. Increased vehicle payload without increased GVWR significantly reduces fuel consumption and CO_2 emissions per ton mile of freight delivered. It also leads to fewer vehicle miles driven with a proportional reduction in traffic accidents.

The empty curb weight of tractors varies significantly today. Items as common as fuel tanks can vary between 50 and 300 gallons each for a given truck model. Information provided by truck manufacturers indicates that there may be as much as a 5,000 to 17,000 pound difference in curb weight between the lightest and heaviest tractors within a regulatory subcategory (such as Class 8 sleeper cab with a high roof). Because there is such a large variation in the baseline weight among trucks that perform roughly similar functions with roughly similar configurations, there is not an effective way to quantify the exact CO_2 and fuel consumption benefit of mass reduction using GEM because of the difficulty in establishing a baseline. However, if the weight reduction is limited to tires and wheels, then both the baseline and weight differentials for these are readily quantifiable and well-understood. Therefore, the agencies are proposing that the mass reduction that would be simulated be limited only to reductions in wheel and tire weight. In the context of this heavy-duty vehicle program with only changes to tires and wheels, the agencies do not foresee any related impact on safety.[49] The agencies welcome comments regarding this approach and detailed data to further improve the robustness of the agencies' assumed baseline truck tare/curb weights for each regulatory category used within the model, as outlined in draft RIA Chapter 3.5.

EPA and NHTSA are proposing to specify the baseline vehicle weight for each regulatory category (including the tires and wheels), but allow manufacturers to quantify weight reductions based on the wheel material selection and single wide versus dual tires per Table II–5. The agencies assume the baseline wheel and tire configuration contains dual tires with steel wheels because these represent the vast majority of new vehicle configurations today. The proposed weight reduction due to the wheels and tires would be reflected in the payload tons by increasing the specified payload by the weight reduction amount discounted by two thirds to recognize that approximately one third of the truck miles are travelled at maximum payload, as discussed below in the payload discussion.

[45] ISO, 2009, Passenger Car, Truck, and Bus Tyres—Methods of Measuring Rolling Resistance—Single Point Test and Correlation of Measurement Results: ISO 28580:2009(E), First Edition, 2009–07–01.

[46] NHTSA, 2009. "NHTSA Tire Fuel Efficiency Consumer Information Program Development: Phase 1—Evaluation of Laboratory Test Protocols." DOT HS 811 119. June. (*http://www.regulations.gov,* Docket ID: NHTSA–2008–0121–0019).

[47] This distribution is equivalent to the Federal over-axle weight limits for an 80,000 GVWR 5-axle tractor-trailer: 12,000 Pounds over the steer axle, 34,000 pounds over the tandem drive axles (17,000 pounds per axle) and 34,000 pounds over the tandem trailer axles (17,000 pounds per axle).

[48] U.S. Environmental Protection Agency. *SmartWay Transport Partnership July 2010 e-update* accessed July 16, 2010, from *http://www.epa.gov/smartwaylogistics/newsroom/documents/e-update-july-10.pdf.*

[49] For more information on the estimated safety effects of this proposed rule, *see* Chapter 9 of the draft RIA.

Table II-5: Proposed Weight Reduction Values

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

(f) Extended Idle Reduction Technology Assessment

Extended idling from Class 8 heavy-duty long haul combination tractors contributes to significant CO_2 emissions and fuel consumption in the United States. The Federal Motor Carrier Safety Administration regulations require a certain amount of driver rest for a corresponding period of driving hours.[50] Extended idle occurs when Class 8 long haul drivers rest in the sleeper cab compartment during rest periods as drivers find it both convenient and less expensive to rest in the truck cab itself than to pull off the road and find accommodations. During this rest period a driver will idle the truck in order to provide heating or cooling or run on-board appliances. In some cases the engine can idle in excess of 10 hours. During this period, the truck will consume approximately 0.8 gallons of fuel and emit over 8,000 grams of CO_2 per hour. An average truck can consume 8 gallons of fuel and emit over 80,000 grams of CO_2 during overnight idling in such a case.

Idling reduction technologies are available to allow for driver comfort while reducing fuel consumptions and CO_2 emissions. Auxiliary power units, fuel operated heaters, battery supplied air conditioning, and thermal storage systems are among the technologies available today. The agencies are proposing to include extended idle reduction technology as an input to the GEM for Class 8 sleeper cabs. The manufacturer would input the value based on the idle reduction technology installed on the truck. As discussed further in Section III, if a manufacturer chooses to use idle reduction technology to meet the standard, then it would require an automatic main engine shutoff after 5 minutes to help ensure the idle reductions are realized in-use. As with all of the technology inputs discussed in this section, the agencies are not mandating the use of idle reductions or idle shutdown, but rather allowing their use as one part of a suite of technologies feasible for reducing fuel consumption and meeting the proposed standards. The proposed value (5 g CO_2/ton-mile or 0.5 gal/1,000 ton-mile) for the idle reduction technologies was determined using an assumption of 1,800 idling hours per year, 125,000 miles travelled, and a baseline idle fuel consumption of 0.8 gallons per hour. Additional detail on the emission and fuel consumption reduction values are included in draft RIA Chapter 2.

(g) Vehicle Speed Limiters

Fuel consumption and CO_2 emissions increase proportional to the square of vehicle speed.[51] 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 a simple technology that is utilized today. The feature is electronically programmed and controlled. Manufacturers today sell trucks with vehicle speed limiters and allow the customers to set the limit. However, as proposed the GEM will not provide a fuel consumption reduction for a limiter that can be overridden. In order to obtain a benefit for the program, the manufacturer must preset the limiter in such a way that the setting will not be capable of being easily overridden by the fleet or the owner. As with other engine calibration aspects of emission controls, tampering with a calibration would be considered unlawful by EPA. If the manufacturer installs a vehicle speed limiter into a truck that is not easily overridden, then the manufacturer would input the vehicle speed limit setpoint into GEM.

(h) Defined Vehicle Configurations in the GEM

As discussed above, the agencies are proposing methodologies that manufacturers would use to quantify the values to be input into the GEM for these factors affecting truck efficiency: Coefficient of Drag, Tire Rolling Resistance Coefficient, Weight Reduction, Vehicle Speed Limiter, and Extended Idle Reduction Technology. The other aspects of vehicle performance are fixed within the model and are not varied for the purpose of compliance. The defined inputs being proposed include the drive cycle, tractor-trailer combination curb weight, payload, engine characteristics, and drivetrain for each vehicle type, and others. We are seeking comments accompanied with data on the defined model inputs as described in draft RIA Chapter 4.

(i) Vehicle Drive Cycles

As noted by the 2010 NAS Report,[52] the choice of a drive cycle used in compliance testing has significant consequences on the technology that will be employed to achieve a standard as well as the ability of the technology to achieve real world reductions in emissions and improvements in fuel consumption. Manufacturers naturally will design vehicles to ensure they satisfy regulatory standards. If the agencies propose an ill-suited drive cycle for a regulatory category, it may encourage GHG emissions and fuel consumption technologies which satisfy the test but do not achieve the same benefits in use. For example, requiring all trucks to use a constant speed highway drive cycle will drive significant aerodynamic improvements. However, in the real world a combination tractor used for local

[50] Federal Motor Carrier Safety Administration. Hours of Service Regulations. Last accessed on August 2, 2010 at *http://www.fmcsa.dot.gov/rules-regulations/topics/hos/*.

[51] *See* 2010 NAS Report, Note 19, Page 28. Road Load Force Equation defines the aerodynamic portion of the road load as ½ * Coefficient of Drag * Frontal Area * air density * vehicle speed squared.

[52] *See* 2010 NAS Report, Note 19, Chapters 4 and 8.

delivery may spend little time on the highway, reducing the benefits that would be achieved by this technology. In addition, the extra weight of the aerodynamic fairings will actually penalize the GHG and fuel consumption performance in urban driving and may reduce the freight carrying capability. The unique nature of the kinds of CO_2 emissions control and fuel consumption technology means that the same technology can be of benefit during some operation but cause a reduced benefit under other operation.[53] To maximize the GHG emissions and fuel consumption benefits and avoid unintended reductions in benefits, the drive cycle should focus on promoting technology that produces benefits during the primary operation modes of the application. Consequently, drive cycles used in GHG emissions and fuel consumption compliance testing should reasonably represent the primary actual use, notwithstanding that every truck has a different drive cycle in-use.

The agencies are proposing a modified version of the California ARB Heavy Heavy-duty Truck 5 Mode Cycle,[54] using the basis of three of the cycles which best mirror Class 7 and 8 combination tractor driving patterns, based on information from EPA's MOVES model.[55] The key advantage of the California ARB 5 mode cycle is that it provides the flexibility to use several different modes and weight the modes to fit specific truck application usage patterns. EPA analyzed the five cycles and found that some modifications to the modes appear to be needed to allow sufficient flexibility in weightings. The agencies are proposing the use of the Transient mode, as defined by California ARB, because it broadly covers urban driving. The agencies are also proposing altered versions of the High Speed Cruise and Low Speed Cruise modes which would reflect only constant speed cycles at 65 mph and 55 mph respectively. EPA and NHTSA relied on the EPA MOVES analysis of Federal Highway Administration data to develop the proposed mode weightings to characterize typical operations of heavy-duty trucks, per Table II–6 below.[56] A detailed discussion of drive cycles is included in draft RIA Chapter 3.[57]

Table II-6: Drive Cycle Mode Weightings

	Transient	55 mph Cruise	65 mph Cruise
Day Cabs	19%	17%	64%
Sleeper Cabs	5%	9%	86%

(ii) 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 truck is important because it in part determines the impact of technologies, such as rolling resistance, on GHG emissions and fuel consumption. The agencies are proposing to specify each of these aspects of the vehicle.

The agencies developed the proposed tractor curb weight inputs from actual tractor weights measured in two of EPA's test programs and based on information from the manufacturers. The proposed trailer curb weight inputs were derived from actual trailer weight measurements conducted by EPA and weight data provided to ICF International by the trailer manufacturers.[58] Details of the individual weight inputs by regulatory category are included in draft RIA Chapter 3.

There are several methods that the agencies have considered for evaluating the GHG emissions and fuel consumption of tractors used to carry freight. A key factor in these methods is the weight of the truck that is assumed for purposes of the evaluation. 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, logistics such as delivery demands which require that trucks travel without full loads, the density of payload, and the availability of full loads of freight limit the ability of trucks to operate at their highest efficiency all the time. 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 pounds which is the gross vehicle weight limit on the Federal Interstate Highway System or greater than 80,000 pounds for vehicles traveling on roads outside of the interstate system).[59]

As described above, the amount of payload that a tractor can carry depends on the category (or GVWR) of the vehicle. For example, a typical Class 7 tractor can carry less payload than a Class 8 tractor. The Federal Highway Administration developed Truck Payload Equivalent Factors to inform the development of highway system strategies using Vehicle Inventory and Use Survey (VIUS) and Vehicle Travel Information System data. Their results

[53] This situation does not typically occur for heavy-duty emission control technology designed to control criteria pollutants such as PM and NO_X.

[54] California Air Resources Board. Heavy Heavy-duty Diesel Truck chassis dynamometer schedule, Transient Mode. Last accessed on August 2, 2010 at *http://www.dieselnet.com/standards/cycles/hhddt.html.*

[55] EPA's MOVES (Motor Vehicle Emission Simulator). *See http://www.epa.gov/otaq/models/moves/index.htm* for additional information.

[56] The Environmental Protection Agency. Draft MOVES2009 Highway Vehicle Population and Activity Data. EPA–420–P–09–001, August 2009 *http://www.epa.gov/otaq/models/moves/techdocs/420p09001.pdf.*

[57] In the light-duty vehicle rule, EPA and NHTSA based compliance with tailpipe standards on use of the FTP and HFET, and declined to use alternative tests. *See* 75 FR 25407. NHTSA is mandated to use the FTP and HFET tests for CAFE standards, and all relevant data was obtained by FTP and HFET testing in any case. *Id.* Neither of these constraints exists for Class 7–8 tractors. The little data which exist on current performance are principally measured by the ARB Heavy Heavy-duty Truck 5 Mode Cycle testing, and NHTSA is not mandated to use the FTP to establish heavy-duty fuel economy standards. *See* 49 U.S.C. 32902(k)(2) authorizing NHTSA, among other things, to adopt and implement appropriate "test methods, measurement metrics, * * * and compliance protocols".

[58] 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.

[59] 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.

found that the average payload of a Class 8 truck ranged from 36,247 to 40,089 pounds, depending on the average distance travelled per day.[60] The same results found that Class 7 trucks carried between 18,674 and 34,210 pounds of payload also depending on average distance travelled per day. Based on this data, the agencies are proposing to prescribe a fixed payload of 25,000 pounds for Class 7 tractors and 38,000 pounds for Class 8 tractors for their respective test procedures. The agencies are proposing a common payload for Class 8 day cabs and sleeper cabs because the data available does not distinguish based on type of Class 8 tractor. These 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." Additional details on proposed payloads are included in draft RIA Chapter 3.

(iii) Standardized Trailers

NHTSA and EPA are proposing that the tractor performance in the GEM would be judged by assuming it is pulling a standardized trailer. The agencies believe that an assessment of the tractor aerodynamics should be conducted using a tractor-trailer combination to reflect the impact of aerodynamic technologies in actual use, where tractors are designed and used with a trailer. Assessing the tractor aerodynamics using only the tractor would not be a reasonable way to assess in-use impacts. For example, the in-use aerodynamic drag while pulling a trailer is different than without the trailer and the full impact of an aerodynamic technology on reducing emissions and fuel consumption would not be reflected if the assessment is performed on a tractor without a trailer.

In addition to assessing the tractor with a trailer, it is appropriate to adopt a standardized trailer used for testing, and to vary the standardized trailer by the regulatory category. This is similar to the standardization of payload discussed above, as a way to reasonably reflect in-use operating conditions. High roof tractors are optimally designed to pull box trailers. The roof fairing on a tractor is the feature designed to minimize the height differential between the tractor and typical trailer to reduce the air flow disruption. Low roof tractors are designed to carry flat bed or low-boy trailers. Mid roof tractors are designed to carry tanker and bulk carrier trailers. The agencies conducted a survey of tractor-trailer pairing in-use to evaluate the representativeness of this premise. The survey of over 3,000 tractor-trailer combinations found that in 95 percent of the combination tractors the tractor's roof height was paired appropriately for the type of trailer that it was pulling.[61] The agencies also have evaluated the impact of pairing a low roof tractor with a box trailer in coastdown testing and found that the aerodynamic force increases by 20 percent over a high roof tractor pulling the same box trailer.[62] Therefore, drivers have a large incentive to use the appropriate matching to reduce their fuel costs. However, the agencies recognize that in operation tractors sometimes pull trailers other than the type that it was designed to carry. The agencies are proposing the matching of trailers to roof height for the test procedure. To do otherwise would necessarily result in a standard reflecting substandard aerodynamic performance, and thereby result in standards which are less stringent than would be appropriate based on the reasonable assumption that tractors will generally pair with trailer of appropriate roof height. The other aspects of the test procedure such as empty trailer weight, location of payload, and tractor-trailer gap are being proposed for each regulatory category to provide consistent test procedures.

(iv) Standardized Drivetrain

The agencies' assessment of the current vehicle configuration process at the truck dealer's level is that the truck companies provide tools to specify the proper drivetrain matched to the buyer's specific circumstances. These dealer tools allow a significant amount of customization for drive cycle and payload to provide the best specification for the customer. The agencies are not seeking to disrupt this process. Optimal drivetrain selection is dependent on the engine, drive cycle (including vehicle speed and road grade), and payload. Each combination of engine, drive cycle, and payload has a single optimal transmission and final drive ratio. The agencies are proposing to specify the engine's fuel consumption map, drive cycle, and payload; therefore, it makes sense to also specify the drivetrain that matches.

(v) Engine Input to GEM

As the agencies are proposing separate engine and tractor standards, the GEM will be used to assess the compliance of the tractor with the tractor standard. To maintain the separate assessments, the agencies are proposing to define the engine characteristics used in GEM, including the fuel consumption map which provides the fuel consumption at hundreds of engine speed and torque points. If the agencies did not standardize the fuel map, then a tractor that uses an engine with emissions and fuel consumption better than the standards would require fewer vehicle reductions than those technically feasible reductions being proposed. The agencies are proposing two distinct fuel consumption maps for use in GEM. EPA proposes the first fuel consumption map would be used in GEM for the 2014 through 2016 model years and represents an average engine which meets the 2014 model year engine CO_2 emissions standards being proposed. NHTSA proposes to use the same fuel map for its voluntary standards in the 2014 and 2015 model years, as well as its mandatory program in the 2016 model year. A second fuel consumption map would be used beginning in 2017 model year and represents an engine which meets the 2017 model year CO_2 emissions and fuel consumption standards and accounts for the increased stringency in the proposed MY 2017 standard. Effectively there is no change in stringency of the tractor vehicle (not including the engine) and there is stability in the tractor vehicle (not including engine) standards for the full rulemaking period.[63] These inputs are appropriate given the separate proposed regulatory requirement that Class 7 and 8 combination tractor manufacturers use only certified engines.

(i) Engine Test Procedure

The NAS panel did not specifically discuss or recommend a metric to evaluate the fuel consumption of heavy-duty engines. However, as noted above they did recommend the use of a load-specific fuel consumption metric for the evaluation of vehicles.[64] An analogous metric for engines would be the amount of fuel consumed per unit of work. Thus, EPA is proposing that GHG emission standards for engines under the CAA would be expressed as g/bhp-

[60] 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.*

[61] U.S. EPA. Truck and Trailer Roof Height Match Analysis Memorandum from Amy Kopin to the Docket, August 9, 2010. Docket Identification Number EPA–HQ–OAR–2010–0162–0045.

[62] *See* the draft RIA Chapter 2 for additional detail.

[63] As noted earlier, use of the 2017 model year fuel consumption map as a GEM input results in numerically more stringent proposed vehicle standards for MY 2017.

[64] See NAS Report, Note 19, at page 39.

hr; NHTSA's proposed fuel consumption standards under EISA, in turn, would be represented as gal/100 bhp-hr. This metric is also consistent with EPA's current standards for non-GHG emissions for these engines.

EPA's criteria pollutant standards for engines require that manufacturers demonstrate compliance over the transient Heavy-duty FTP test cycle; the steady-state SET test cycle; and the not-to-exceed test (NTE test). EPA created this multi-layered approach to criteria emissions control in response to engine designs that optimized operation for lowest fuel consumption at the expense of very high criteria emissions when operated off the regulatory cycle. EPA's use of multiple test procedures for criteria pollutants helps to ensure that manufacturers calibrate engine systems for compliance under all operating conditions. With regard to GHG and fuel consumption control, the agencies believe it is more appropriate to set standards based on a single test procedure, either the Heavy-duty FTP or SET, depending on the primary expected use of the engine. For engines used primarily in line-haul combination tractor trailer operations, we believe the steady-state SET procedure more appropriately reflects in-use engine operation. By setting standards based on the most representative test cycle, we can have confidence that engine manufacturers will design engines for the best GHG and fuel consumption performance relative to the most common type of expected engine operation. There is no incentive to design the engines to give worse fuel consumption under other types of operation, relative to the most common type of operation, and we are not concerned if manufacturers further calibrate these designs to give better in-use fuel consumption during other operation, while maintaining compliance with the criteria emissions standards as such calibration is entirely consistent with the goals of our joint program.

Further, we are concerned that setting standards based on both transient and steady-state operating conditions for all engines could lead to undesirable outcomes. For example, turbocompounding is one technology that the agencies have identified as a likely approach for compliance against our proposed HHD SET standard described below. Turbocompounding is a very effective approach to lower fuel consumption under steady driving conditions typified by combination tractor trailer operation and is well reflected in testing over the SET test procedure. However, when used in driving typified by transient operation as we expect for vocational vehicles and as is represented by the Heavy-duty FTP, turbocompounding shows very little benefit. Setting an emission standard based on the Heavy-duty FTP only for engines intended for use in combination tractor trailers could lead manufacturers to not apply turbocompounding because the full benefits are not demonstrated on the Heavy-duty FTP even though it can be a highly cost-effective means to reduce GHG emissions and lower fuel consumption in more steady state applications.

The current non-GHG emissions engine test procedures also require the development of regeneration emission rates and frequency factors to account for the emission changes during a regeneration event (40 CFR 86.004–28). EPA and NHTSA are proposing to exclude the CO_2 emissions and fuel consumption increases due to regeneration from the calculation of the compliance levels over the defined test procedures. We considered including regeneration in the estimate of fuel consumption and GHG emissions and have decided not to do so for two reasons. First, EPA's existing criteria emission regulations already provide a strong motivation to engine manufacturers to reduce the frequency and duration of infrequent regeneration events. The very stringent 2010 NO_X emission standards cannot be met by engine designs that lead to frequent and extend regeneration events. Hence, we believe engine manufacturers are already reducing regeneration emissions to the greatest degree possible.

In addition to believing that regenerations are already controlled to the extent technologically possible, we believe that attempting to include regeneration emissions in the standard setting could lead to an inadvertently lax emissions standard. In order to include regeneration and set appropriate standards, EPA and NHTSA would have needed to project the regeneration frequency and duration of future engine designs in the timeframe of this proposal. Such a projection would be inherently difficult to make and quite likely would underestimate the progress engine manufacturers will make in reducing infrequent regenerations. If we underestimated that progress, we would effectively be setting a more lax set of standards than otherwise would be expected. Hence in setting a standard including regeneration emissions we faced the real possibility that we would achieve less effective CO_2 emissions control and fuel consumption reductions than we will achieve by not including regeneration emissions. We are seeking comments regarding regeneration emissions and what approach if any the agencies should use in reflecting regeneration emissions in this program.

In conclusion, for Class 7 and 8 tractors, compliance with the vehicle standard would be determined by establishing values for the variable inputs and using the prescribed inputs in GEM and compliance against the engine standard using the SET engine cycle. The model would produce CO_2 and fuel consumption results that would be compared against EPA's and NHTSA's respective standards.

(j) Chassis-Based Test Procedure

The agencies also considered proposing a chassis-based vehicle test to evaluate Class 7 and 8 tractors based on a laboratory test of the engine and vehicle together. A "chassis dynamometer test" for heavy-duty vehicles would be similar to the Federal Test Procedure used today for light-duty vehicles.

However, the agencies decided not to propose the use of a chassis test procedure to demonstrate compliance for tractor standards due to the significant technical hurdles to implementing such a program by the 2014 model year. The agencies recognize that such testing requires expensive, specialized equipment that is not yet widespread within the industry. The agencies have only identified approximately 11 heavy-duty chassis sites in the United States today and rapid installation of new facilities to comply with model year 2014 is not possible.[65]

In addition, and of equal if not greater importance, because of the enormous numbers of truck configurations that have an impact on fuel consumption, we do not believe that it would be reasonable to require testing of many combinations of tractor model configurations on a chassis dynamometer. The agencies evaluated the options available for one tractor model (provided as confidential business information from a truck manufacturer) and found that the company offered three cab configurations, six axle configurations, five front axles, 12 rear axles, 19 axle ratios, eight engines, 17 transmissions, and six tire sizes—where each of these options could impact the fuel consumption and CO_2 emissions of the

[65] For comparison, engine manufacturers typically own a large number of engine dynamometer test cells for engine development and durability (up to 100 engine dynamometers per manufacturer).

tractor. Even using representative grouping of tractors for purposes of certification, this presents the potential for many different combinations that would need to be tested if a standard was adopted based on a chassis test procedure.

Although the agencies are not proposing the use of a complete chassis based test procedure for Class 7 and 8 tractors, we believe such an approach could be appropriate in the future, if more testing facilities become available and if the agencies are able to address the complexity of tractor configurations issue described above. We request comments on the potential use of chassis based test procedures in the future to augment or replace the model based approach we are proposing.

(3) Summary of Proposed Flexibility and Credit Provisions

EPA and NHTSA are proposing four flexibility provisions specifically for heavy-duty tractor and engine manufacturers, as discussed in Section IV below. These are an averaging, banking and trading program for emissions and fuel consumption credits, as well as provisions for early credits, advanced technology credits, and credits for innovative vehicle or engine technologies which are not included as inputs to the GEM or are not demonstrated on the engine SET test cycle.

The agencies are proposing that credits earned by manufacturers under this ABT program be restricted for use to only within the same regulatory subcategory for two reasons. First, relating credits between categories is tenuous because of the differences in regulatory useful lives. We want to avoid having credits from longer useful life categories flooding shorter useful life categories, adversely impacting compliance with CO_2 or fuel consumption standards in the shorter useful life category, and we have not based the level of the standard on such impact on compliance. In addition, extending the use of credits beyond these designated categories could inadvertently have major impacts on the competitive market place, and we want to avoid such results. For example, a manufacturer which has multiple engine offerings over several regulatory categories could mix credits across engine categories and shift the burden between them, possibly impacting the competitive market place. Similarly, integrated manufacturers which produce both engines and trucks could shift credits between engines and trucks and have a similar effect. We would like to ensure that this proposal reduces the CO_2 emissions and fuel consumption but does not inadvertently have such impacts on the market place. However, we welcome comments on the extension of credits beyond the limitations we are proposing.

The agencies are also proposing to provide provisions to manufacturers for early credits, the use of advanced technologies and innovative technologies which are described in greater detail in Section IV.

(4) Deferral of Standards for Tractor and Engine Manufacturing Companies That Are Small Businesses

EPA and NHTSA are proposing to defer greenhouse gas emissions and fuel consumption standards for small tractor or engine manufacturers meeting the Small Business Administration (SBA) size criteria of a small business as described in 13 CFR 121.201.[66] The agencies will instead 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 tractor or engine manufacturers.

The agencies have identified two entities that fit the SBA size criterion of a small business.[67] The agencies estimate that these small entities comprise less than 0.5 percent of the total heavy-duty combination tractors in the United States based on Polk Registration Data from 2003 through 2007,[68] and therefore that the exemption will have a negligible impact on the GHG emissions and fuel consumption improvements from the proposed standards.

To ensure that the agencies are aware of which companies would be exempt, we propose to require that such entities submit a declaration to EPA and NHTSA containing a detailed written description of how that manufacturer qualifies as a small entity under the provisions of 13 CFR 121.201.

C. Heavy-Duty Pickup Trucks and Vans

The primary elements of the EPA and NHTSA programs being proposed for complete HD pickups and vans are presented in this section. These provisions also cover incomplete HD pickups and vans that are sold by vehicle manufacturers as cab-chassis (chassis-cab, box-delete, bed-delete, cut-away van) vehicles, as discussed in detail in Section V.B(1)(e). Section II.C(1) explains the proposed form of the CO_2 and fuel consumption standards, the proposed numerical levels for those standards, and the proposed approach to phasing in the standards over time. The proposed measurement procedure for determining compliance is discussed in Section II.C(2), and the proposed EPA and NHTSA compliance programs are discussed in Section II.C(3). Sections II.C(4) discusses proposed implementation flexibility provisions. Section II.E discusses additional standards and provisions for N_2O and CH_4 emissions, for impacts from vehicle air conditioning, and for ethanol-fueled and electric vehicles.

(1) What Are the Proposed Levels and Timing of HD Pickup and Van Standards?

(a) Vehicle-Based Standards

About 90 percent of Class 2b and 3 vehicles are pickup trucks, passenger vans, and work vans that are sold by the vehicle 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 today (*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 only the engines covered by CAA engine emission standards, expressed in grams per brake horsepower-hour.[69] As a result, Class 2b and 3 complete vehicles share much more in common with light-duty trucks than with other heavy-duty vehicles.

Three of these commonalities 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 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

[66] *See* § 1036.150 and § 1037.150.

[67] The agencies have identified Ottawa Truck, Inc. and Kalmar Industries USA as two potential small tractor manufacturers.

[68] M.J. Bradley. Heavy-duty Vehicle Market Analysis. May 2009.

[69] As discussed briefly in Section I and in more detail in Section V, this regulatory category also covers some incomplete Class 2b/3 vehicles.

brakes), and the manufacturer is generally responsible for both engine and vehicle design. All of these factors together suggest that it is appropriate and reasonable to set standards for the vehicle as a whole, rather than to establish separate engine and vehicle GHG and fuel consumption standards, as is proposed for the other heavy-duty categories. This approach for complete vehicles is consistent with Recommendation 8–1 of the NAS Report, which encourages the regulation of "the final stage vehicle manufacturers since they have the greatest control over the design of the vehicle and its major subsystems that affect fuel consumption."

(b) Weight-Based Attributes

In setting heavy-duty vehicle standards it is important to take into account the great diversity of vehicle sizes, applications, and features. That diversity reflects the variety of functions performed by heavy-duty vehicles, and this in turn can affect the kind of technology that is available to control emissions and reduce fuel consumption, and its effectiveness. EPA has dealt with this diversity in the past by making weight-based distinctions where necessary, for example in setting HD vehicle standards that are different for vehicles above and below 10,000 lb GVWR, and in defining different standards and useful life requirements for light-, medium-, and heavy-heavy-duty engines. Where appropriate, distinctions based on fuel type have also been made, though with an overall goal of remaining fuel-neutral.

The joint EPA GHG and NHTSA fuel economy rules for light-duty vehicles accounted for vehicle diversity in that segment by basing standards on vehicle footprint (the wheelbase times the average track width). Passenger cars and light trucks with larger footprints are assigned numerically higher target levels for GHGs and numerically lower target levels for fuel economy in acknowledgement of the differences in technology as footprint gets larger, such that vehicles with larger footprints have an inherent tendency to burn more fuel and emit more GHGs per mile of travel. Using a footprint-based attribute to assign targets also avoids interfering with the ability of the market to offer a variety of products to maintain consumer choice.

In developing this proposal, 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, consistent with the NAS report recommendations to be mindful of HD vehicles' unique purposes. Despite the HD pickup and van similarities to light-duty vehicles, we believe that the past practice in EPA's heavy-duty program of using weight-based distinctions in dealing with the diversity of HD pickup and van products is more appropriate than using vehicle footprint. Weight-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 this category have a wide range of payload and towing capacities. These weight-based differences in design and in-use operation are the 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 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.[70]

Towing, on the other hand, does not directly factor into test weight as nothing is towed during the test. Hence only the higher curb weight caused by 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 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.

Although heavy-duty vehicles are traditionally classified by their GVWR, we do not believe that GVWR is the best weight-based attribute on which to base GHG and fuel consumption standards for this group of vehicles. GVWR is a function of not only payload capacity but of vehicle curb weight as well; in fact, it is the simple sum of the two. Allowing more GHG emissions from vehicles with higher curb weight tends to penalize lightweighted vehicles with comparable payload capabilities by making them meet more stringent standards than they would have had to meet without the weight reduction. The same would be true for another common weight-based measure, the gross vehicle combined weight, which adds the maximum combined towing and payload weight to the curb weight.

Similar concerns about using weight-based attributes that include vehicle curb weight were raised in the EPA/NHTSA proposal for light-duty GHG and fuel economy standards: "Footprint-based standards provide an incentive to use advanced lightweight materials and structures that would be discouraged by weight-based standards", and "there is less risk of 'gaming' (artificial manipulation of the attribute(s) to achieve a more favorable target) by increasing footprint under footprint-based standards than by increasing vehicle mass under weight-based standards—it is relatively easy for a manufacturer to add enough weight to a vehicle to decrease its applicable fuel economy target a significant amount, as compared to increasing vehicle footprint" (74 FR 49685, September 28, 2009). The agencies believe that using payload and towing capacities as the weight-based attributes would avoid the above-mentioned disincentive for the use of lightweighting technology by taking vehicle curb weight out of the standards determination.

After taking these considerations into account, EPA and NHTSA have decided to propose standards for HD pickups and vans based on a "work factor" attribute that combines vehicle payload capacity and vehicle towing capacity, in pounds, with an additional fixed adjustment for four-wheel drive (4wd) vehicles. This adjustment would account for the fact that 4wd, critical to enabling the many off-road heavy-duty work applications, adds roughly 500 lb to the vehicle weight. Under our proposal, target GHG and fuel consumption standards would be determined for each vehicle with a unique work factor. These targets would then be production weighted and summed to derive a manufacturer's annual fleet average standards.

To ensure consistency and help preclude gaming, we are proposing that payload capacity be defined as GVWR minus curb weight, and towing capacity as GCWR minus GVWR. We are proposing that, for purposes of determining the work factor, GCWR be defined according to SAE Recommended Practice J2807 APR2008, GVWR be defined consistent with EPA's criteria pollutants program, and curb weight be defined as in 40 CFR

[70] Section II.C(2) discusses our decision to propose that GHGs and fuel consumption for HD pickups and vans be measured using the same test conditions as in the existing EPA program for criteria pollutants.

86.1803–01. We request comment on the need to establish additional regulations or guidance to ensure that these terms are determined and applied consistently across the HD pickup and van industry for the purpose of determining standards.

Based on analysis of how CO_2 emissions and fuel consumption correlate to work factor, we believe that a straight line correlation is appropriate across the spectrum of possible HD pickups and vans, and that vehicle distinctions such as Class 2b versus Class 3 need not be made in setting standards levels for these vehicles.[71] We request comment on this proposed approach.

We note that payload/towing-dependent gram per mile and gallon per 100 mile standards for HD pickups and vans parallel the gram per ton-mile and gallon per 1,000 ton-mile standards being proposed for Class 7 and 8 combination tractors and for vocational vehicles. Both approaches account for the fact that more work is done, more fuel is burned, and more CO_2 is emitted in moving heavier loads than in moving lighter loads. Both of these load-based approaches avoid penalizing truck designers wishing to reduce GHG emissions and fuel consumption by reducing the weight of their trucks. However, the sizeable diversity in HD work truck and van applications, which go well beyond simply transporting freight, and the fact that the curb weights of these vehicles are on the order of their payload capacities, suggest that setting simple gram/ton-mile and gallon/ton-mile standards for them is not appropriate. Even so, we believe that our proposal of payload-based standards for HD pickups and vans is consistent with the NAS Report's recommendation in favor of load-specific fuel consumption standards.

These attribute-based CO_2 and fuel consumption standards are meant to be relatively consistent 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 would be affected by the standard. With the proposed 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.

(c) Proposed Standards

The agencies are proposing standards based on a technology analysis performed by EPA to determine the appropriate HD pickup and van standards. This analysis, described in detail in draft RIA Chapter 2, considered:

- The level of technology that is incorporated in current new HD pickups and vans,
- The available data on corresponding 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 2018 model year,
- The effectiveness and cost of these technologies for HD pickup and vans,
- Projections of future U.S. sales for HD pickup and vans, and
- Forecasts of manufacturers' product redesign schedules.

Based on this analysis, EPA is proposing the CO_2 attribute-based target standards shown in Figure II–1 and II–2, and NHTSA is proposing the equivalent attribute-based fuel consumption target standards, also shown in Figure II–1 and II–2, applicable in model year 2018. These figures also shows phase-in standards for model years before 2018, and their derivation is explained below, along with alternative implementation schedules to ensure equivalency between the EPA and NHTSA programs while meeting statutory obligations. Also, for reasons discussed below, separate targets are being established 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 standards that apply to the combined diesel and gasoline fleet of HD pickups and vans produced by a manufacturer in each model year.

[71] Memorandum from Anthony Neam and Jeff Cherry, U.S.EPA, to docket EPA–HQ–OAR–2010–0162, October 18, 2010.

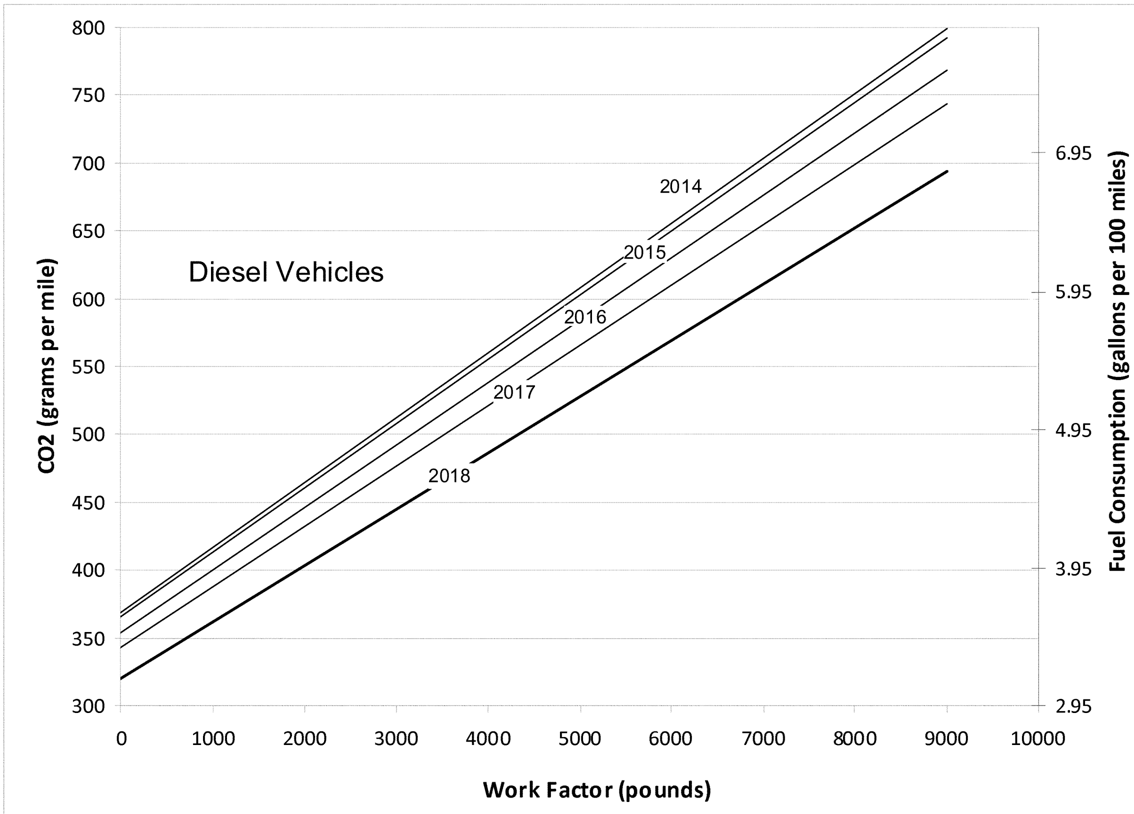

Figure II-1: Proposed EPA CO_2 Target Standards and NHTSA Fuel Consumption Target Standards for Diesel HD Pickups and Vans[72]

[72] The NHTSA proposal provides voluntary standards for model years 2014 and 2015. Target line functions for 2016–2018 are for the second NHTSA alternative described in Section II.C(d)(ii).

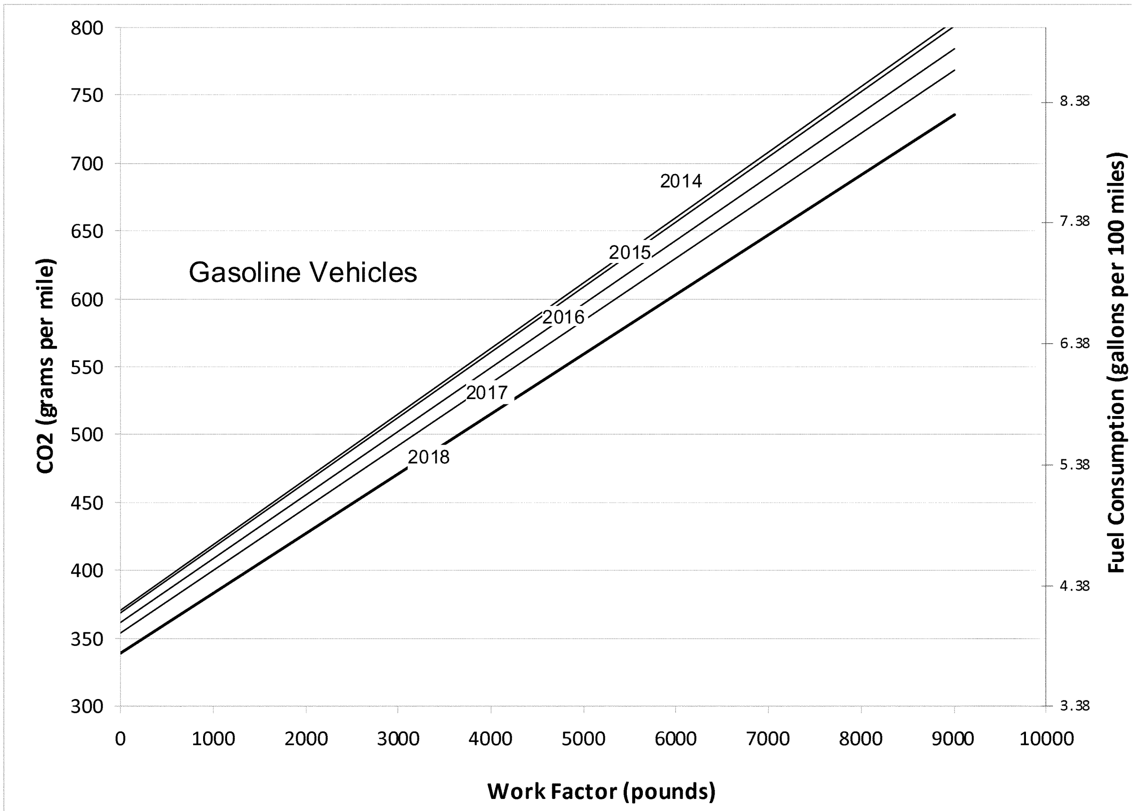

Figure II-2: Proposed EPA CO_2 Target Standards and NHTSA Fuel Consumption Target Standards for Gasoline HD Pickups and Vans[73]

Described[73] mathematically, EPA's and NHTSA's proposed functions are defined by the following formulae:

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 II–7 or Table II–8.[74]

[73] The NHTSA proposal provides voluntary standards for model years 2014 and 2015. Target line functions for 2016–2018 are for the second NHTSA alternative described in Section II.C(d)(ii).

[74] The NHTSA proposal provides voluntary standards for model years 2014 and 2015. Target line functions for 2016–2018 are for the second NHTSA alternative described in Section II.C(d)(ii).

Table II-7: Coefficients for Proposed HD Pickup and Van Target Standards[74]

Diesel Vehicles				
Model Year	a	b	c	d
2014	0.0478	368	0.000470	3.62
2015	0.0474	366	0.000466	3.59
2016	0.0460	354	0.000452	3.48
2017	0.0445	343	0.000437	3.37
2018	0.0416	320	0.000408	3.15
Gasoline Vehicles				
Model Year	a	b	c	d
2014	0.0482	371	0.000473	3.65
2015	0.0479	369	0.000471	3.63
2016	0.0469	362	0.000461	3.55
2017	0.0460	354	0.000452	3.48
2018	0.0440	339	0.000432	3.33

Table II-8: Coefficients Proposed for NHTSA's First Alternative and EPA's Alternative HD Pickup and Van Target Standards

Diesel Vehicles				
Model Year	a	b	c	d
2014[a]	0.0478	368	0.000470	3.62
2015[a]	0.0474	366	0.000466	3.59
2016-2018	0.0440	339	0.000432	3.33
2019	0.0416	320	0.000408	3.15
Gasoline Vehicles				
Model Year	a	b	c	d
2014[a]	0.0482	371	0.000473	3.65
2015[a]	0.0479	369	0.000471	3.63
2016-2018	0.0456	352	0.000448	3.45
2019	0.0440	339	0.000432	3.33

Notes:
[a] NHTSA standards would be voluntary in 2014 and 2015

These targets are based on a set of vehicle, engine, and transmission technologies assessed by the agencies and determined to be feasible and appropriate for HD pickups and vans in the 2014–2018 timeframe. Much of the information used to make this technology assessment was developed for the recent 2012–2016 MY light-duty vehicle rule. *See* Section III.B for a detailed analysis of these vehicle, engine and transmission technologies, including their feasibility, costs, and effectiveness in HD pickups and vans.

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 estimate that in 2018 the target curves will achieve 15 and 10 percent reductions in CO_2 and fuel consumption for diesel and gasoline vehicles, respectively, relative to a common baseline for current (model year 2010) vehicles. An additional two percent reduction in GHGs would be achieved by the EPA program from a proposed direct air conditioning leakage standard. These reductions are based on the agencies' assessment of the feasibility of incorporating technologies (which differ significantly for gasoline and diesel powertrains) in the 2014–2018 model years, and on the differences in relative efficiency in the current gasoline and diesel vehicles. The resulting reductions represent roughly equivalent stringency levels for gasoline and diesel vehicles, which is important in ensuring our proposed program maintains product choices available to vehicle buyers.

The NHTSA fuel consumption target curves and the 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 would generally be equivalent to fuel consumption. However, as explained below in Section II. E. (3), EPA is proposing an alternative for manufacturers to demonstrate compliance with N_2O and CH_4 emissions standards through the calculation of a CO_2-equivalent (CO_2eq) emissions level that would be compared to the CO_2-based standards, similar to the recently promulgated light-duty GHG standards for model years 2012–2016. For test families that do not use this compliance alternative, the measured performance values for CO_2 and fuel consumption would be equivalent because the same test runs and measurement data would be used to determine both values, and calculated fuel consumption would be based on the same conversion factors that are used to establish the relationship between the CO_2 and fuel consumption target curves (8887 g CO_2/gallon for gasoline and 10,180 g CO_2/gallon for diesel fuel). In this case, for example, if a manufacturer's fleet average measured compliance value exactly meets the fleet average CO_2 standard, it will also exactly meet the fuel consumption standard. The proposed NHTSA fuel consumption program will not use a CO_2eq metric. Measured performance to standards would be based on the measurement of CO_2 with no adjustment for N_2O and CH_4. For manufacturers that choose to use the EPA CO_2eq approach, compliance with the CO_2 standard would not be directly equivalent to compliance with the NHTSA fuel consumption standard.

(d) Proposed Implementation Plan

(i) EPA Program Phase-In MY 2014–2018

EPA is proposing that the GHG standards be phased in gradually over the 2014–2018 model years, with full implementation effective in the 2018 model year. Therefore, 100 percent of a manufacturer's vehicle fleet would need to meet a fleet-average standard that would become increasingly more stringent each year of the phase-in period. For both gasoline and diesel vehicles, this phase-in would be 15–20–40–60–100 percent in model years 2014–2015–2016–2017–2018, respectively. These percentages reflect stringency increases from a baseline performance level for model year 2010, determined by the agencies based on EPA and manufacturer data. Because these vehicles are not currently regulated for GHG emissions, this phase-in takes the form of target line functions for gasoline and diesel vehicles that become increasingly stringent over the phase-in model years. These year-by-year functions have been derived in the same way as the 2018 function, by taking a percent reduction in CO_2 from a common unregulated baseline. For example, in 2014 the reduction for both diesel and gasoline vehicles would be 15% of the fully-phased-in reductions. Figures II–1 and II–2, and Table II–7, reflect this phase-in approach.

EPA is also proposing to provide manufacturers with an optional alternative implementation schedule in model years 2016 through 2018, equivalent to NHTSA's proposed first alternative for standards that do not change over these model years, described below. Under this option the phase-in would be 15–20–67–67–67–100 percent in model years 2014–2015–2016–2017–2018–2019, respectively. Table II–8, above, provides the coefficients "a" and "b" for this manufacturer's alternative. As explained below, the stringency of this alternative was established by NHTSA such that a manufacturer with a stable production volume and mix over the model year 2016–2018 period could use Averaging, Banking and Trading to comply with either alternative and have a similar credit balance at the end of model year 2018.

Under the above-described alternatives, each manufacturer would need to demonstrate compliance with the applicable fleet average standard using that year's target function over all of its HD pickups and vans starting in 2014. EPA also requests comment on a different regulatory approach to the phase-in, intended to reduce the testing and certification burden on manufacturers during the 2014–2017 phase-in years, while achieving GHG reductions on the same schedule as the proposed phase-in. In this alternative approach, each manufacturer would be required to demonstrate compliance with the final 2018 targets, but only over a predefined percentage of its HD pickup and van production. The remaining vehicles produced each year would not be regulated for GHGs. Thus this approach would have the effect of setting final standards in 2014 that do not vary over time, but with an annually increasing set of regulated vehicles. The percentage of regulated vehicles would increase each year, to 100 percent in 2018. We think it likely that manufacturers would leave the highest emitting vehicles unregulated for as long as possible under this approach, because these vehicles would tend to be the costliest to redesign or may simply be phased out of production. We therefore expect that, to be equivalent, the percentage penetration each year would be higher than the 15–20–40–60 percent penetrations required under the proposed approach. EPA requests comment on this regulatory alternative, and on what percentage penetrations are appropriate to achieve equivalent program benefits.

(ii) NHTSA Program Phase-In 2016 and Later

NHTSA is proposing to allow manufacturers to select one of two fuel consumption standard alternatives for model years 2016 and later. Manufacturers would select an alternative at the same time they submit the model year 2016 Pre-Certification Compliance Report; and, once selected, the alternative would apply for model years 2016 and later, and could not be reversed. To meet the EISA statutory requirement for three years of regulatory stability, the first alternative would define a fuel consumption target line function for gasoline vehicles and a target line function for diesel vehicles that would not change for model years 2016 and later. The proposed target line function coefficients are provided in Table II–8.

The second alternative would be equivalent to the EPA target line functions in each model year starting in 2016 and continuing afterwards. Stringency of fuel consumption standards would increase gradually for the 2016 and later model years. Relative to a model year 2010 unregulated baseline, for both gasoline and diesel vehicles, stringency would be 40, 60, and 100 percent of the 2018 target line function in model years 2016, 2017, and 2018, respectively.

The stringency of the target line functions in the first alternative for model years 2016–2017–2018–2019 is 67–67–67–100 percent, respectively, of the 2018 stringency in the second alternative. The stringency of the first alternative was established so that a manufacturer with a stable production volume and mix over the model year 2016–2018 period, could use Averaging, Banking and Trading to comply with either alternative and have a similar credit balance at the end of model year 2018 under the EPA and NHTSA programs.

NHTSA also requests comment on a different regulatory approach that would parallel the above-described EPA regulatory alternative involving certification of a pre-defined percentage of a manufacturer's HD pickup and van production.

(iii) NHTSA Voluntary Standards Period

NHTSA is proposing that manufacturers may voluntarily opt into the NHTSA HD pickup and van program in model years 2014 or 2015. If a manufacturer elects to opt into the program, the program would become mandatory and the manufacturer would not be allowed to reverse this decision. To opt into the program, a manufacturer must declare its intent to opt in to the program at the same time it submits the Pre-Certification Compliance Report. *See* proposed regulatory text for 49 CFR 535.8 for information related to the Pre-Certification Compliance Report. If a manufacturer elects to opt into the program in 2014, the program would be mandatory for 2014 and 2015. A manufacturer would begin tracking credits and debits beginning in the model year in which they opt into the program. The handling of credits and debits would be the same as for the mandatory program.

For manufacturers that opt into NHTSA's HD pickup and van fuel consumption program in 2014 or 2015, the stringency would increase gradually each model year. Relative to a model year 2010 unregulated baseline, for both gasoline and diesel vehicles, stringency would be 15–20 percent of the model year 2018 target line function (under the NHTSA second alternative) in model years 2014–2015, respectively. The corresponding absolute standards targets levels are provided in Figure II–1 and II–2, and the accompanying equations.

NHTSA also requests comment on a different regulatory approach that would parallel the above-described EPA regulatory alternative involving certification of a pre-defined percentage of a manufacturer's HD pickup and van production.

(2) What are the proposed HD pickup and van test cycles and procedures?

EPA and NHTSA are proposing that HD pickup and van testing be conducted 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) currently required only for light-duty vehicle GHG emissions and fuel economy testing. Although the highway cycle driving pattern would be identical to that of the light-duty test, other test parameters for running the HFET, such as test vehicle loaded weight, would be identical to those used in running the current EPA Federal Test Procedure for complete heavy-duty vehicles.

The GHG and fuel consumption results from vehicle testing on the Light-duty FTP and the HFET would be weighted by 55 percent and 45 percent, respectively, and then averaged in calculating a combined cycle result. This result corresponds with the data used to develop the proposed work factor-based CO_2 and fuel consumption standards, since the data on the baseline and technology efficiency was also developed in the context of these test procedures. The addition of the HFET and the 55/45 cycle weightings are the same as for the light-duty CO_2 and CAFE programs, as we believe the real world driving patterns for HD pickups and vans are not too unlike those of light-duty trucks, and we are not aware of data specifically on these patterns that would lead to a different choice of cycles and weightings. More importantly, we believe that the 55/45 weightings will provide for effective reductions of GHG emissions and fuel consumption from these vehicles, and that other weightings, even if they were to more precisely match real world patterns, are not likely to significantly improve the program results.

Another important parameter in ensuring a robust test program is vehicle test weight. Current EPA testing for HD pickup and van criteria pollutants is conducted with the vehicle loaded to its Adjusted Loaded Vehicle Weight (ALVW), that is, its curb weight plus ½ of the payload capacity. This is substantially more challenging than loading to the light-duty vehicle test condition of curb weight plus 300 pounds, but we believe that this loading for HD pickups and vans to ½ payload better fits their usage in the real world and would help ensure that technologies meeting the standards do in fact provide real world reductions. The choice is likewise consistent with use of an attribute based in considerable part on payload for the standard. We see no reason to set test load conditions differently for GHGs and fuel consumption than for criteria pollutants, and we are not aware of any new information (such as real world load patterns) since the ALVW was originally set this way that would support a change in test loading conditions. We are therefore proposing to use ALVW for test vehicle loading in GHG and fuel consumption testing.

EPA and NHTSA request comment on the proposed test cycles, weighting factors, test loading conditions, and other factors that are important for establishing an effective GHG and fuel consumption test program. Additional provisions for our proposed testing and compliance program are provided in Section V.B.

(3) How are the HD pickup and van standards structured?

EPA and NHTSA are proposing fleet average standards for new HD pickups and vans, based on a manufacturer's new vehicle fleet makeup. In addition, EPA is proposing in-use standards that would apply to the individual vehicles in this fleet over their useful lives. The compliance provisions for these proposed fleet average and in-use standards for HD pickups and vans are largely based on the recently promulgated light-duty GHG and fuel economy program, as described below and in greater detail in Section V.B. We request comment on any compliance provisions we have taken from the light-duty program that commenters feel would not be appropriate for HD pickups and vans or that should be adjusted in some way to better regulate HD GHGs and fuel consumption cost-effectively.

(a) Fleet Average Standards

In this proposal we outline how each manufacturer would have a GHG standard and a fuel consumption standard unique to its new HD pickup and van fleet in each model year, depending on the load capacities 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 would have individual targets at numerically higher CO_2 and fuel consumption levels than lower payload/towing vehicles would, as discussed in Section II.C(1). The fleet average standard for a manufacturer would be 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.

The fleet average standard with which the manufacturer must comply would 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 ended. 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 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 would issue a certificate for the vehicles covered by the test group based on this demonstration, and would 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 light-duty program, additional "model type" testing would 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 would 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. *See* generally 75 FR 25470–25472.

EPA and NHTSA do not currently anticipate notable deterioration of CO_2 emissions and fuel consumption performance, and are therefore proposing that an assigned deterioration factor be applied at the time of certification: an additive assigned deterioration factor of zero, or a multiplicative factor of one would be used. EPA and NHTSA anticipate that the deterioration factor would be updated from time to time, as new data regarding emissions deterioration for CO_2 are obtained and analyzed. Additionally, EPA and NHTSA may consider technology-specific deterioration factors, should data indicate that certain control technologies deteriorate differently than others. *See also* 75 FR 25474.

(b) 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. The in-use standards that EPA is proposing would apply to individual vehicles. NHTSA is not proposing to adopt in-use standards because it is not required under EISA, and because it is not currently anticipated that there will be any notable deterioration of fuel consumption. For the EPA proposal, compliance with the in-use standard for individual vehicles and vehicle models will not impact compliance with the fleet average standard, which will be based on the production weighted average of the new vehicles.

EPA is proposing that the in-use standards for HD pickups and vans be established by adding an adjustment factor to the full useful life emissions and fuel consumption results used to calculate the fleet average. EPA is also proposing that the useful life for these vehicles with respect to GHG emissions be set equal to their useful life for criteria pollutants: 11 years or 120,000 miles, whichever occurs first (40 CFR 86.1805–04(a)).

As discussed above, we are proposing that certification test results obtained before and during the model year be used directly to calculate the fleet average emissions for assessing compliance with the fleet average standard. Therefore, this assessment and the fleet average standard itself do not take into account test-to-test variability and production variability that can affect measured in-use levels. For this reason, EPA is proposing an adjustment factor for the in-use standard to provide some margin for production and test-to-test variability that could result in differences between the initial emission test results used to calculate the fleet average and emission results obtained during subsequent in-use testing. EPA is proposing that each model's in-use CO_2 standard would be the model-specific level used in calculating the fleet average, plus 10 percent. This is the same as the approach taken for light-duty vehicle GHG in-use standards (*See* 75 FR 25473–25474).

As it does now for heavy-duty vehicle criteria pollutants, EPA would use a variety of mechanisms to conduct assessments of compliance with the proposed in-use standards, including pre-production certification and in-use monitoring once vehicles enter customer service. The full useful life in-use standards would apply to vehicles that had entered customer service. The same standards would apply to vehicles used in pre-production and production line testing, except that deterioration factors would not be applied.

(4) What HD pickup and van flexibility provisions are being proposed?

This proposal contains substantial flexibility in how manufacturers can choose to implement the EPA and NHTSA standards while preserving their timely benefits for the environment and energy security. Primary among these flexibilities are the gradual phase-in schedule, alternative compliance paths, and corporate fleet average approach described above. Additional flexibility provisions are described briefly here and in more detail in Section IV.

As explained in Section II.C(3), we are proposing that at the end of each model year, when production for the model year is complete, a manufacturer calculate its production-weighted fleet average CO_2 and fuel consumption. Under this proposed 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 would 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. These provisions exist in the 2012–2016 MY light-duty vehicle National Program, and similar provisions are part of EPA's Tier 2 program for light-duty vehicle criteria pollutant emissions, as well as many other mobile source standards issued by EPA under the CAA. The manufacturer would 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 years, consistent with the light-duty program. We are proposing that, after satisfying any need to offset pre-existing deficits, a manufacturer may bank remaining credits for use in future years. We are also proposing that manufacturers may certify their HD pickup and van fleet a year early, in MY 2013, to generate credits against the MY 2014 standards. This averaging, banking, and trading program for HD pickups and vans is discussed in more detail in Section IV.A. For reasons discussed in detail in that section, we are not proposing any credit transferability to or from other credit programs, such as the light-duty GHG and fuel consumption programs or the proposed heavy-duty engine ABT program.

Consistent with the President's May 21, 2010 directive to promote advanced technology vehicles, we are proposing and seeking comment on flexibility provisions that would parallel similar provisions adopted in the light-duty program. These include credits for advance technology vehicles such as electric vehicles, and credits for innovative technologies that are shown by the manufacturer to provide GHG and fuel consumption reductions in real world driving, but not on the test cycle. *See* Section IV.B.

We believe that it may also be appropriate to take steps to recognize the benefits of flexible-fueled vehicles (FFVs) and dedicated alternative-fueled vehicles based on the approach taken by EPA in the light-duty vehicle rule for later models years (2016 and later). However, unlike in that rule, we do not believe it is appropriate to create a provision for additional credits similar to the 2012–2015 light-duty program because the HD sector does not have the incentives mandated in EISA for light-duty vehicles. In fact, since heavy-duty vehicles were not included in the EISA incentives for FFVs, manufacturers have not in the past produced FFV heavy-duty vehicles. On the other hand, we do seek comment on how to properly recognize the impact of the use of alternative fuels, and E85 in particular, in HD pickups and vans, including the proper accounting for alternative fuel use in FFVs in the real world.[75] As proposed, FFV performance would be determined in the same way as for light-duty vehicles, with a 50–50 weighting of alternative and conventional fuel test results through MY 2015, and a manufacturer-determined weighting based on demonstrated fuel use in the real world after MY 2015 (defaulting to an assumption of 100 percent conventional fuel use). For dedicated alternative fueled vehicles, NHTSA proposes that vehicles be tested with the alternative fuel, and a petroleum equivalent fuel consumption level be calculated based on the Petroleum Equivalency Factor (PEF) that is determined by the Department of Energy. However, we are accepting comment on whether to provide a flexibility program similar to the program we currently offer for light-duty FFV vehicles.

D. Class 2b–8 Vocational Vehicles

Class 2b–8 vocational vehicles consist of a very wide variety of configurations including delivery, refuse, utility, dump, cement, transit bus, shuttle bus, school bus, emergency vehicle, motor homes,[76] and tow trucks, among others. The agencies are defining that Class 2b–8 vocational vehicles are all heavy-duty vehicles which are not included in the Heavy-duty Pickup Truck and Van or the Class 7 and 8 Tractor categories, with the exception of vehicles for which the agencies are deferring setting of standards, such as small business manufacturers. In addition, recreational vehicles are included under EPA's proposed standards but are not included under NHTSA's proposed standards.

As mentioned in Section I, vocational vehicles undergo a complex build process. Often an incomplete chassis is built by a chassis manufacturer with an engine purchased from an engine manufacturer and a transmission purchased from another manufacturer. A body manufacturer purchases an incomplete chassis which is then completed by attaching the appropriate features to the chassis.

The agencies face difficulties in establishing the baseline CO_2 and fuel consumption performance for the wide variety of vocational vehicles which makes it difficult to try and set different standards for a large number of potential regulatory categories. The diversity in the vocational vehicle segment can be primarily attributed to the variety of vehicle bodies 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 will lead to different baseline 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) will be the same between these two types of complete vehicles. Furthermore, the agencies evaluated the aerodynamic improvement opportunities for vocational vehicles. For example, the aerodynamics of a fire truck are impacted significantly by the equipment such as ladders located on the exterior of the truck. The agencies found little opportunity to improve the aerodynamics of the equipment on the truck. The agencies also evaluated the aerodynamic opportunities discussed in the NAS report. The panel found that there was no fuel consumption reduction opportunity through aerodynamic technologies for bucket trucks, transit buses, and refuse trucks[77] primarily due to the low vehicle speed in normal operation. The panel did report that there are opportunities to reduce the fuel consumption of straight trucks by approximately 1 percent for trucks which operate at the average speed typical of a pickup and delivery truck (30 mph), although the opportunity is greater for trucks which operate at higher speeds.[78] To overcome the lack of baseline information from the different vehicle applications without sacrificing much fuel consumption or GHG emission reduction potential, the agencies propose to set standards for the chassis manufacturers of vocational vehicles (instead of the body builders) and the engine manufacturers.

EPA is proposing CO_2 standards and NHTSA is proposing fuel consumption standards for manufacturers of chassis for new vocational vehicles and for manufacturers of heavy-duty engines installed in these vehicles. The proposed heavy-duty engine standards for CO_2 emissions and fuel consumption would focus on potential technological improvements in fuel combustion and overall engine efficiency and those proposed controls would achieve most of the emission reductions. Further reductions from the Class 2b–8 vocational vehicle itself are possible within the timeframe of these proposed regulations. Therefore, the agencies are also proposing separate standards for vocational vehicles that will focus on additional reductions that can be achieved through improvements in vehicle tires. The agencies' analyses, as discussed briefly below and in more detail later in this preamble and in the draft RIA Chapter 2, show that these proposed standards appear appropriate under each agency's respective statutory authorities. Together these standards are estimated to achieve reductions of up to 11 percent from vocational vehicles.

EPA is also proposing standards to control N_2O and CH_4 emissions from Class 2b–8 vocational vehicles. The proposed heavy-duty engine standards for both N_2O and CH_4 and details of the standard are included in the discussion in Section II. EPA is not proposing air conditioning leakage standards applying to chassis manufacturers to address HFC emissions.

As discussed further below, the agencies propose to set CO_2 and fuel consumption standards for these chassis based on tire rolling resistance improvements and for the engines based on engine technologies. The fuel consumption and GHG emissions impact of tire rolling resistance is impacted by the mass of the vehicle. However the impact of mass on rolling resistance is relatively small so the agencies propose to aggregate several vehicle weight categories under a single category for setting the standards. The agencies propose to divide the vocational vehicle segment into three broad regulatory categories—Light

[75] E85 is a blended fuel consisting of nominally 15 percent gasoline and 85 percent ethanol.

[76] *See* above for discussion of applicability of NHTSA's standards to non-commercial vehicles.

[77] *See* 2010 NAS Report, Note 19, page 133.

[78] *See* 2010 NAS Report, Note 19, page 110.

Heavy-Duty (Class 2b through 5), Medium Heavy-Duty (Class 6 and 7), and Heavy Heavy-Duty (Class 8) which is consistent with the nomenclature used in the diesel engine classification. The agencies are interested in comment on this segmentation strategy (subcategorization). As the agencies move towards future heavy-duty fuel consumption and GHG regulations for post-2017 model years, we intend to gather GHG and fuel consumption data for specific vocational applications which could be used to establish application-specific standards in the future.

(1) What are the proposed CO_2 and fuel consumption standards and their timing?

In developing the proposed standards, the agencies have evaluated the current levels of emissions and fuel consumption, the kinds of technologies that could be utilized by manufacturers to reduce emissions and fuel consumption and the associated lead time, the associated costs for the industry, fuel savings for the consumer, and the magnitude of the CO_2 and fuel savings that may be achieved. The technologies that the agencies considered while setting the proposed vehicle-level standards include improvements in lower rolling resistance tires. The technologies that the agencies considered while setting the engine standards include engine friction reduction, aftertreatment optimization, among others. The agencies' evaluation indicates that these technologies are available today in the heavy-duty tractor and light-duty vehicle markets, but have very low application rates in the vocational market. The agencies have analyzed the technical feasibility of achieving the proposed CO_2 and fuel consumption standards, based on projections of what actions manufacturers would be expected to take to reduce emissions and fuel consumption to achieve the standards, and believe that the proposed standards are cost-effective and technologically feasible and appropriate within the rulemaking time frame. EPA and NHTSA also present the estimated costs and benefits of the proposed vocational vehicle standards in Section III.

(a) Proposed Chassis Standards

As shown in Table II–9, EPA is proposing the following CO_2 standards for the 2014 model year for the Class 2b through Class 8 vocational vehicle chassis. Similarly, NHTSA is proposing the following fuel consumption standards for the 2016 model year, with voluntary standards beginning in the 2014 model year. For the EPA GHG program, the proposed standard applies throughout the useful life of the vehicle.

EPA and NHTSA are proposing more stringent vehicle standards for the 2017 model year which reflect the CO_2 emissions reductions required through the 2017 model year engine standards. As explained in Section II. D. (2)(c)(iv) below, engine performance is one of the inputs into the compliance model, and that input will change in 2017 to reflect the 2017 MY engine standards. The 2017 MY vehicle standards are not premised on manufacturers installing additional vehicle technologies.

Table II-9: Proposed Class 2b-8 Vocational Vehicle CO_2 and Fuel Consumption Standards

EPA CO_2 (gram/ton-mile) Standard Effective 2014 Model Year			
	Light Heavy-Duty Class 2b-5	Medium Heavy-Duty Class 6-7	Heavy Heavy-Duty Class 8
CO_2 Emissions	358	212	109
NHTSA Fuel Consumption (gallon per 1,000 ton-mile) Standard Effective 2016 Model Year[79]			
	Light Heavy-Duty Class 2b-5	Medium Heavy-Duty Class 6-7	Heavy Heavy-Duty Class 8
Fuel Consumption	35.2	20.8	10.7
EPA CO_2 (gram/ton-mile) Standard Effective 2017 Model Year			
	Light Heavy-Duty Class 2b-5	Medium Heavy-Duty Class 6-7	Heavy Heavy-Duty Class 8
CO_2 Emissions	344	204	107
NHTSA Fuel Consumption (gallon per ton-mile) Standard Effective 2017 Model Year			
	Light Heavy-Duty Class 2b-5	Medium Heavy-Duty Class 6-7	Heavy Heavy-Duty Class 8
Fuel Consumption	33.8	20.0	10.5

(i) Off-Road Vocational Vehicle Standards

In developing the proposal EPA and NHSTA received comment from manufacturers and owners that certain vocational vehicles sometimes have very limited on-road usage. These trucks are defined to be motor vehicles under 40 CFR 85.1703, but they will spend the majority of their operations off-road. Trucks, such as those used in oil fields, will experience little benefit from low rolling resistance tires. The agencies are therefore proposing to allow a narrow range of these *de facto* off-road trucks to be excluded from the proposed vocational vehicle standards because the trucks require special off-road tires such as lug tires. The trucks must still use a certified engine, which will provide fuel consumption and CO_2 emission reductions to the truck in all

[79] Manufacturers may voluntarily opt-in to the NHTSA fuel consumption program in 2014 or 2015. If a manufacturer opts-in, the program becomes mandatory.

applications. To insure that these trucks are in fact used chiefly off-road, the agencies are proposing requirements that the vehicles have off-road tires, have limited high speed operation, and are designed for specific off-road applications. The agencies are specifically proposing that a truck must meet the following requirements to qualify for an exemption from the vocational vehicle standards:

- Installed tires which are lug tires or contain a speed rating of less than or equal to 60 mph; and
- Include a vehicle speed limiter governed to 55 mph.

EPA and NHTSA have concluded that the on-road performance losses and additional costs to develop a truck which meets these specifications will limit the exemption to trucks built for the desired purposes. The agencies welcome comment on the proposed requirements and exemptions.

(b) Proposed Heavy-duty Engine Standards

EPA is proposing GHG standards [80] and NHTSA is proposing fuel consumption standards for new heavy-duty engines installed in vocational vehicles. The standards will vary depending on whether the engines are diesel or gasoline powered. The agencies' analyses, as discussed briefly below and in more detail later in this preamble and in the draft RIA Chapter 2, show that these standards are appropriate and feasible under each agency's respective statutory authorities.

The agencies have analyzed the feasibility of achieving the GHG and fuel consumption standards, based on projections of what actions manufacturers are expected to take to reduce emissions and fuel consumption. EPA and NHTSA also present the estimated costs and benefits of the heavy-duty engine standards in Section III. In developing the proposed rules, the agencies have evaluated the kinds of technologies that could be utilized by engine manufacturers compared to a baseline engine, as well as the associated costs for the industry and fuel savings for the consumer and the magnitude of the GHG and fuel consumption savings that may be achieved.

With respect to the lead time and cost of incorporating technology improvements that reduce GHG emissions and fuel consumption, the agencies place important weight on the fact that during MYs 2014–2017, engine manufacturers are expected to redesign and upgrade their products only once. Over these four model years there will be an opportunity for manufacturers to evaluate almost every one of their engine models and add technology in a cost-effective way to control GHG emissions and reduce fuel consumption. The time-frame and levels for the standards, as well as the ability to average, bank and trade credits and carry a deficit forward for a limited time, are expected to provide manufacturers the time needed to incorporate technology that will achieve the proposed GHG and fuel consumption reductions, and to do this as part of the normal engine redesign process. This is an important aspect of the proposed rules, as it will avoid the much higher costs that would occur if manufacturers needed to add or change technology at times other than these scheduled redesigns. This time period will also provide manufacturers the opportunity to plan for compliance using a multi-year time frame, again in accord with their normal business practice. Further details on lead time, redesigns and technical feasibility can be found in Section III.

EPA's existing criteria pollutant emissions regulations for heavy-duty highway engines establish four regulatory categories (three for compression-ignition or diesel engines and one for spark ignition or gasoline engines) that represent the engine's intended and primary truck application, as shown in Table II–10 (40 CFR 1036.140). The agencies welcome comments on the existing definition of the regulatory categories (such as typical horsepower levels) as described in 40 CFR 1036.140. All heavy-duty engines are covered either under the heavy-duty pickup truck and van category or under the heavy-duty engine standards.

Table II-10: Engine Regulatory Subcategories

Engine Category	Intended Application
Light Heavy-duty (LHD) Diesel	Class 2b through Class 5 trucks (8,501 through 19,500 pounds GVWR)
Medium Heavy-duty (MHD) Diesel	Class 6 and Class 7 trucks (19,501 through 33,000 pounds GVWR)
Heavy Heavy-duty (HHD) Diesel	Class 8 trucks (33,001 pounds and greater GVWR
Gasoline	Incomplete vehicles less than 14,000 pounds GVWR and all vehicles (complete or incomplete) greater than 14,000 pounds GVWR

For the purposes of the GHG engine emissions and engine fuel consumption standards that EPA and NHTSA are proposing, the agencies intend to maintain these same four regulatory subcategories for GHG engine emissions standards and fuel consumption standards. This category structure would enable the agencies to set standards that appropriately reflect the technology available for engines for use in each type of vehicle.

(i) Diesel Engine Standards

EPA's proposed heavy-duty diesel engine CO_2 emission standards are presented in Table II–11. Similar to EPA's non-GHG standards approach, manufacturers may generate and use credits to show compliance with the standards. The EPA standards become effective in 2014 model year, with more stringent standards becoming effective in model year 2017. Recently, EPA's

[80] Specifically, EPA is proposing CO_2, N_2O, and CH_4 emissions standards for new heavy-duty engines over an EPA specified useful life period (*see* Section II. E. for the N_2O and CH_4 standards).

non-GHG heavy-duty engine program provided new emissions standards for the industry in three year increments. Largely, the heavy-duty engine and truck manufacturer product plans have fallen into three year cycles to reflect this environment. The proposed two-step CO_2 emission standards recognize the opportunity for technology improvements over this timeframe while reflecting the typical diesel truck manufacturer product plan cycles.

NHTSA's fuel consumption standards, also presented in Table II–11, would contain voluntary engine standards starting in 2014 model year, with mandatory engine standards starting in 2017 model year, synchronizing with EPA's 2017 model year standards. A manufacturer may opt-in to NHTSA's voluntary standards in 2014, 2015 or 2016. Once a manufacturer opts-in, the standards become mandatory for the opt-in and subsequent model years, and the manufacturer may not reverse its decision. To opt into the program, a manufacture must declare its intent to opt in to the program with documented communication of the intent, at the same time it submits the Pre-Certification Compliance Report. *See* 49 CFR 535.8 for information related to the Pre-Certification Compliance Report. A manufacturer opting into the program would begin tracking credits and debits beginning in the model year in which they opt into the program.

The agencies are proposing the same standard level for the Light Heavy and Medium Heavy diesel engine categories. The agencies found that there is an overlap in the displacement of engines which are currently certified as LHDD or MHDD. The agencies developed the baseline 2010 model year CO_2 emissions from data provided to EPA by the manufacturers during the non-GHG certification process. Analysis of CO_2 emissions from 2010 model year LHD and MHDD diesel engines showed little difference between LHD and MHD diesel engine baseline CO_2 performance, which overall averaged 630 g CO_2/bhp-hr (6.19 gal/100 bhp-hr),[81] in the 2010 model year. Furthermore, the technologies available to reduce fuel consumption and CO_2 emissions from these two categories of engines are similar. The agencies are proposing to maintain these two separate engine categories with the same standard level (instead of combining them into a single category) to respect the different useful life periods associated with each category. The agencies are proposing to evaluate compliance with the LHD/MHD diesel engine standards based on the Heavy-duty FTP cycle.

The agencies found a difference in the baseline 2010 model year CO_2 and fuel consumption performance between the LHD/MHD diesel engines, which averaged 630 g CO_2/bhp-hr (6.19 gal/100 bhp-hr),[82] and the HHD diesel engines, which averaged 584 g CO_2/bhp-hr (5.74 gal/100 bhp-hr). The HHD diesel engine data is also based on manufacturer submitted CO_2 data for non-GHG emissions certification process. In addition, the agencies believe that there may be some technologies available to reduce fuel consumption and CO_2 emissions that may not be appropriate for both the LHD/MHD diesel and the HHD diesel engines, such as turbocompounding. Therefore, the agencies are proposing a standard level for HHD diesel engines which differs from the LHD/MHD diesel engine standard level likewise to be evaluated on the Heavy-duty FTP cycle.

We are proposing standards based on the Heavy-duty FTP cycle for engines used in vocational vehicles reflecting their primary use in transient operating conditions typified by both frequent accelerations and decelerations as well as some steady cruise conditions as represented on the Heavy-duty FTP. The primary reason the agencies are proposing to set two separate HHD diesel engine standards—one for HHD diesel engines used in tractors and the other for HHD diesel engines used in vocational vehicles—is to encourage engine manufacturers to install technologies appropriate to the intended use of the engine with the vehicle. Tractors spend the majority of their operation at steady state conditions, and will obtain in-use benefit of technologies such as turbocompounding and other waste heat recovery technologies during this kind of typical engine operation. Therefore, the engines installed in line haul tractors would be required to meet the standard based on the SET, which is a steady state test cycle. On the other hand, vocational vehicles such as urban delivery trucks spend more time operating in transient conditions and may not realize the benefit of this type of technology in-use. The use of the Heavy-duty FTP for these engines would focus engine design on technologies that realize in-use benefits during the kind of operation typical for these engines. Therefore, we are proposing that engines installed in vocational vehicles be required to meet the standard and demonstrate compliance over the transient Heavy-duty FTP cycle. The levels of the standards reflect the difference in baseline emissions for the different test procedures.

As noted in Section II.B above, the engine standards that EPA is proposing and the voluntary standards being proposed by NHTSA for the 2014 model year would require diesel engine manufacturers to achieve on average a three percent reduction in fuel consumption and CO_2 emissions over the baseline 2010 model year performance for the HHD diesel engines and a five percent reduction for the LHD and MHD diesel engines. The agencies' assessment of the NAS report and other literature sources indicates that there are technologies available to reduce fuel consumption by this level in the proposed timeframe in a cost-effective manner. These technologies include improved turbochargers, aftertreatment optimization, low temperature exhaust gas recirculation, and engine friction reductions. Additional discussion on technical feasibility is included in Section III below and in draft RIA Chapter 2.

Additionally, the agencies are proposing that diesel engines further reduce fuel consumption and CO_2 emissions in the 2017 model year. The proposed 2017 model year standards for the LHD and MHD diesel engines represent a 9 percent reduction from the 2010 model year. The proposed reductions represent on average a five percent decrease over the 2010 baseline for HHD diesel engines required to test compliance using the Heavy-duty FTP test cycle. The additional reductions may be achieved through the increased development of the technologies evaluated for the 2014 model year standard. *See* draft RIA Chapter 2. The agencies' analysis indicates that this type of advanced engine development will require a longer development time than the 2014 model year and therefore are proposing to provide additional lead time to allow for its introduction.

Similar to EPA's non-GHG standards approach, manufacturers may generate and use credits by the same engine subcategory to show compliance with both agencies' standards.

[81] Calculated using the conversion 10,180 g CO_2/gallon for diesel fuel.

[82] Calculated using the conversion 10,180 g CO_2/gallon for diesel fuel.

Table II-11: 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
2014-2016	CO_2 Standard (g/bhp-hr)	600	600	567
	Voluntary Fuel Consumption Standard (gallon/100 bhp-hr)	5.89	5.89	5.57
2017 and Later	CO_2 Standard (g/bhp-hr)	576	576	555
	Fuel Consumption (gallon/100 bhp-hr)	5.57	5.57	5.45

In proposing these standards for diesel engines used in vocational vehicles, the agencies have looked primarily at the typical performance levels of the majority of engines in the fleet. As explained above in Section II.B, we also recognize that when regulating a category of products for the first time, there will be individual products that may deviate from this baseline level of performance. Recognizing that for these products a reduction from the industry baseline may be more costly than the agencies have assumed or perhaps even not feasible in the lead time available for these standards, EPA and NHTSA are proposing a regulatory alternative whereby a manufacturer could comply with a unique standard based on a five percent reduction from the products own 2011 baseline level. Our assessment is that this five percent reduction is appropriate and technologically feasible given the manufacturers' ability to apply similar technology packages with similar cost to what we have estimated for the primary program. For this purpose, the agencies do not see that potential obstacles are greater or lesser for engine standards which are based on the SET procedure or Heavy-duty FTP cycle. We do not believe this alternative needs to continue past 2016 since manufacturers will have had ample opportunity to benchmark competitive products and make appropriate changes to bring their product performance into line with the rest of the industry.

However, we are requesting comment on the potential to extend this regulatory alternative for one additional year for a single engine family with performance measured in that year as nine percent beyond the engine's own 2011 model year baseline level. We also request comment on the level of reduction beyond the baseline that is appropriate in this alternative. The five percent level reflects the aggregate improvement beyond the baseline we are requiring of the entire industry. As this provision is intended to address potential issues for legacy products that we would expect to be replaced or significantly improved at the manufacturer's next product change, we request comment if a two percent reduction would be more appropriate. We would consider two percent rather than five percent if we were convinced that making all of the changes we have outlined in our assessment of the technical feasibility of the standards was not possible for some engines due to legacy design issues that will change in the next design cycle. We are proposing that manufacturers making use of these provisions would need to exhaust all credits within this subcategory prior to using this flexibility and would not be able to generate emissions credits from other engines in the same regulatory subcategory as the engines complying using this alternate approach.

(ii) Gasoline Engine Standard

Heavy-duty gasoline engines are also used in vocational vehicle applications. The number of engines certified in the past for this segment of vehicles is very limited and has ranged between three and five engine models. Unlike the purpose-built heavy-duty diesel engines typical of this segment, these gasoline engines are developed for heavy-duty pickup trucks and vans primarily, but are also sold as loose engines to vocational vehicle manufacturers. Therefore, the agencies evaluated these engines in parallel with the heavy-duty pickup truck and van standard development. As with the pickup truck and van segment, the agencies anticipate that the manufacturers will have only one engine re-design within the 2014–18 model years under consideration within this proposal. In our meetings with all three of the major manufacturers in this segment, confidential future product plans were shared with the agencies. Reflecting those plans and our estimates for when engine changes will be made in alignment with those product plans, we have concluded that the 2016 model year reflects the most logical model year start date for the heavy-duty gasoline engine standards. In order to meet the standards we are proposing for heavy-duty pickups and vans, we project that all manufacturers will have redesigned their gasoline engine offerings by the start of the 2016 model year. Given the small volume of loose gasoline engine sales relative to complete heavy-duty pickup sales, we think it is appropriate to set the timing for the heavy-duty gasoline engine standard in line with our projections for engine redesigns to meet the heavy-duty pickup truck standards. Therefore, NHTSA's proposed fuel consumption standard and EPA's proposed CO_2 standard for heavy-duty gasoline engines are first effective in the 2016 model year.

The baseline 2010 model year CO_2 performance of these heavy-duty gasoline engines over the Heavy-duty FTP cycle is 660 g CO_2/bhp-hr (6.48 gal/100 bhp-hr) in 2010 based on non-GHG certification data provided to EPA by the manufacturers. The agencies propose that manufacturers achieve a five percent reduction in CO_2 in the 2016 model year over the 2010 MY baseline through use of technologies such as coupled cam phasing, engine friction reduction, and stoichiometric gasoline direct injection. Additional detail on technology feasibility is included in Section III and in the draft RIA Chapter 2.

NHTSA is proposing a 7.05 gallon/100 bhp-hr standard for fuel consumption while EPA is proposing a 627 g CO_2/bhp-hr standard tested over the Heavy-duty FTP, effective in the 2016 model year. Similar to EPA's non-GHG standards approach, manufacturers may generate and use credits by the same engine subcategory to show compliance with both agencies' standards.

In the preceding section on diesel engines, we describe an alternative compliance approach for diesel engines based on improvements from an engine's own baseline of performance. We are not making a similar proposal for gasoline engines, but we request comment on the need for and appropriateness of such an approach. Comments suggesting the need for a similar approach should include specific recommendations on how the approach would work and the technical reasons why such an approach would be necessary in order to make the gasoline engine standards feasible.

(c) In-Use Standards

Section 202(a)(1) of the CAA specifies that emissions standards are to be applicable for the useful life of the vehicle. The in-use standards that EPA is proposing would apply to individual vehicles and engines. NHTSA is not proposing to adopt in-use standards that would apply to the vehicles and engines in a similar fashion.

EPA is proposing that the in-use standards for heavy-duty engines installed in vocational vehicles be established by adding an adjustment factor to the full useful life emissions and fuel consumption results. EPA is proposing a 2 percent adjustment factor for the in-use standard to provide some margin for production and test-to-test variability that could result in differences between the initial emission test results and emission results obtained during subsequent in-use testing.

EPA is proposing that the useful life for these engine and vehicles with respect to GHG emissions be set equal to the respective useful life periods for criteria pollutants. EPA proposes that the existing engine useful life periods, as included in Table II–12, be broadened to include CO_2 emissions and fuel consumption for both engines and tractors (*see* 40 CFR 86.004–2). While NHTSA proposes to use useful life considerations for establishing fuel consumption performance for initial compliance and for ABT, NHTSA does not intend to implement an in-use compliance program for fuel consumption, because it is not required under EISA and because it is not currently anticipated there will be notable deterioration of fuel consumption over the engines' useful life.

Table II-12: Proposed Useful Life Periods

	Years	Miles
Class 2b-5 Vocational Vehicles, Spark Ignited, and Light Heavy-Duty Diesel Engines	10	110,000
Class 6-7 Vocational Vehicles and Medium Heavy-Duty Diesel Engines	10	185,000
Class 8 Vocational Vehicles and Heavy Heavy-Duty Diesel Engines	10	435,000

EPA requests comments on the magnitude and need for an in-use adjustment factor for the engine standard and the compliance model GEM, based chassis standard.

(2) Test Procedures and Related Issues

The agencies are proposing test procedures to evaluate fuel consumption and CO2 emissions of vocational vehicles in a manner very similar to Class 7 and Class 8 combination tractors. This section describes a simulation model for demonstrating compliance, engine test procedures, and a test procedure for evaluating hybrid powertrains (a potential means of generating credits, although not part of the technology on which the proposed standard is premised).

(a) Computer Simulation Model

As previously mentioned, to achieve the goal of reducing emissions and fuel consumption for both trucks and engines, we are proposing to set separate engine and vehicle-based emission standards. For the vocational vehicles, engine manufacturers would be subject to the engine standards, and chassis manufacturers would be required to install certified engines in their chassis. The chassis manufacturer would be subject to a separate vehicle-based standard that would use the proposed truck simulation model to evaluate the impact of the tire design to determine compliance with the truck standard.

A simulation model, in general, uses various inputs to characterize a vehicle's properties (such as weight, aerodynamics, and rolling resistance) and predicts how the vehicle would behave on the road when it follows a driving cycle (vehicle speed versus time). On a second-by-second basis, the model determines how much engine power needs to be generated for the vehicle to follow the driving cycle as closely as possible. The engine power is then transmitted to the wheels through transmission, driveline, and axles to move the vehicle according to the driving cycle. The second-by-second fuel consumption of the vehicle, which corresponds to the engine power demand to move the vehicle, is then calculated according to the fuel consumption map embedded in the compliance model. Similar to a chassis dynamometer test, the second-by-second fuel consumption is aggregated over the complete drive cycle to determine the fuel consumption of the vehicle.

NHTSA and EPA are proposing to evaluate fuel consumption and CO_2 emissions respectively through a simulation of whole-vehicle operation, consistent with the NAS recommendation to use a truck model to evaluate truck performance. The agencies developed the GEM for the specific purpose of this proposal to evaluate truck performance. The GEM is similar in concept to a number of vehicle simulation tools developed by commercial and government entities. The model developed by the agencies and proposed here was designed for the express purpose of vehicle compliance demonstration and is therefore simpler and less configurable than similar commercial products. This approach gives a compact and quicker tool for evaluating vehicle compliance without the overhead and costs of a more complicated model. Details of the model are included in Chapter 4 of the draft RIA.

GEM is designed to focus on the inputs most closely associated with fuel consumption and CO_2 emissions—*i.e.*, on those which have the largest impacts such as aerodynamics, rolling resistance, weight, and others.

EPA and NHTSA have validated GEM based on the chassis test results from three SmartWay certified tractors tested at Southwest Research Institute. The validation work conducted on these three vehicles is representative of the other Class 7 and 8 tractors. Many aspects of one tractor configuration (such as the engine, transmission, axle configuration, tire sizes, and control systems) are similar to those used on the manufacturer's sister models. For example, the powertrain configuration of a sleeper cab is similar to the one used on a straight truck. Details of the validation testing and its representativeness are included in draft RIA Chapter 4. Overall, the GEM predicted the fuel consumption and CO_2 emissions within 4 percent of the chassis test procedure results for three test cycles—the California ARB Transient cycle, the California ARB High Speed Cruise cycle, and the Low Speed Cruise cycle. These cycles are very similar to the ones the agencies are proposing to utilize in compliance testing. Test to test variation for heavy-duty vehicle chassis testing can be higher than 4 percent based on driver variation. The proposed simulation model is described in greater detail in draft RIA Chapter 4 and is available for download by interested parties at (*http://www.epa.gov/otaq/*). We request comment on all aspects of this approach to compliance determination in general and to the use of the GEM in particular.

The agencies are proposing that for demonstrating compliance, a chassis manufacturer would measure the performance of tires, input the values into GEM, and compare the model's output to the standard. Tires are the only technology on which the agencies' own feasibility analysis for these vehicles is predicated. An example of the GEM input screen is included in Figure II–3. The input values for the simulation model would be derived by the manufacturer from tire test procedure proposed by the agencies in this proposal. The agencies are proposing that the remaining model inputs would be fixed values that are pre-defined by the agencies and are detailed in the draft RIA Chapter 4, including the engine fuel consumption map to be used in the simulation.

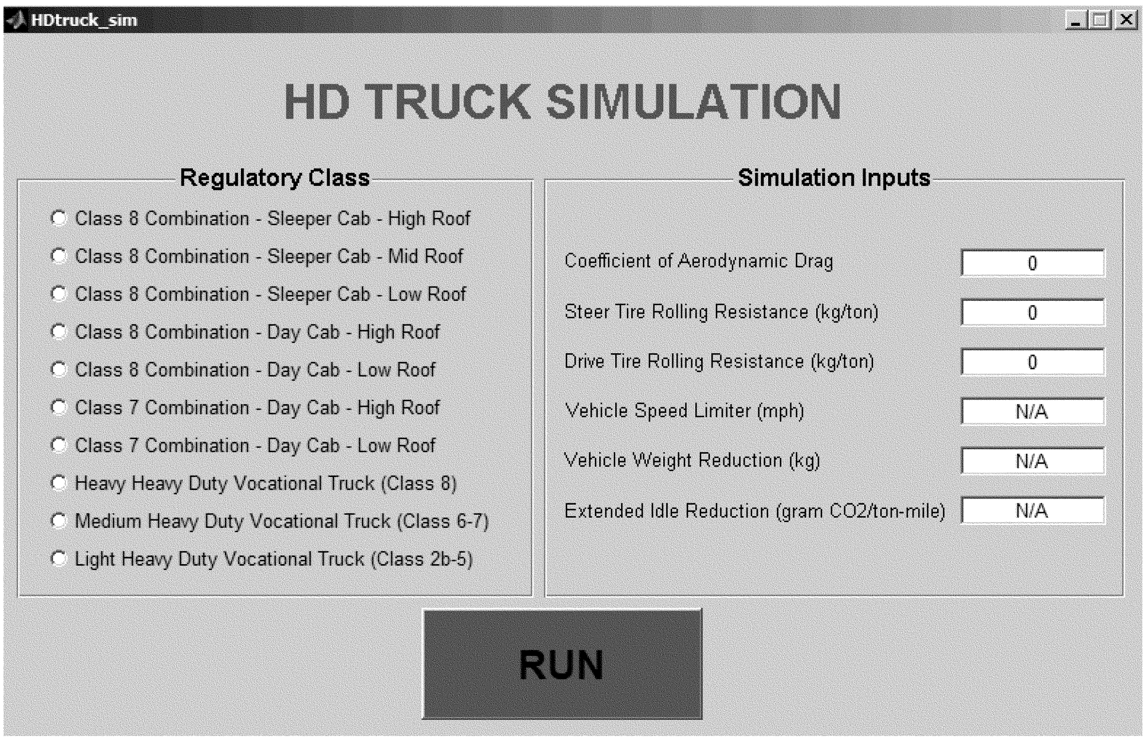

Figure II-3: Example GEM Input Screen

(b)Tire Rolling Resistance Assessment

As with the Class 7 and 8 combination tractors, NHTSA and EPA are proposing that the vocational vehicle's tire rolling resistance input to the GEM be determined using the ISO 28580:2009 test method.[83] The agencies believe the ISO test procedure is appropriate to propose for this program because the procedure is the same one used by the NHTSA tire fuel efficiency labeling program[84] and is consistent with the direction being taken by the tire industry both in the United States and Europe, and with the EPA SmartWay program. The rolling resistance from this test would be used to specify the rolling resistance of each tire on the steer and drive axle of the vehicle. The results would be expressed as a rolling resistance coefficient and measured as kilogram per ton (kg/metric ton). The agencies are proposing that three tire samples within each tire model be tested three times each to account for some of the production variability and the average of the three tests would be the rolling resistance coefficient for the tire.

(c)Defined Vehicle Configurations in the GEM

As discussed above, the agencies are proposing a methodology that chassis manufacturers would use to quantify the tire rolling resistance values to be input into the GEM. Moreover, the agencies are proposing to define the remaining

[83] ISO, 2009, Passenger Car, Truck, and Bus Tyres—Methods of Measuring Rolling Resistance—Single Point Test and Correlation of Measurement Results: ISO 28580:2009(E), First Edition, 2009–07–01.

[84] NHTSA, 2009. "NHTSA Tire Fuel Efficiency Consumer Information Program Development: Phase 1—Evaluation of Laboratory Test Protocols." DOT HS 811 119. June. (*http://www.regulations.gov*, Docket ID: NHTSA–2008–0121–0019).

GEM inputs (*i.e.,* specify them by rule), which may differ by the regulatory subcategory (for reasons described in the draft RIA). The defined inputs being proposed include the drive cycle, aerodynamics, truck curb weight, payload, engine characteristics, and drivetrain for each vehicle type, among others.

(i) Metric

Based on NAS's recommendation and feedback from the heavy-duty truck industry, NHTSA and EPA are proposing standards for vocational vehicles that would be expressed in terms of moving a ton of payload over one mile. Thus, NHTSA's proposed fuel consumption standards for these trucks would be represented as gallons of fuel used to move one ton of payload one thousand miles, or gal/1,000 ton-mile. EPA's proposed CO_2 vehicle standards would be represented as grams of CO_2 per ton-mile.

(ii) Drive cycle

The drive cycle being proposed for the vocational vehicles consists of the same three modes proposed for the Class 7–8 combination tractors. The agencies are thus proposing the use of the Transient mode, as defined by California ARB in the HHDDT cycle, a constant speed cycle at 65 mph and a 55 mph constant speed mode. However, we are proposing different weightings for each mode than proposed for Class 7 and 87 and 8 combination tractors, given the known difference in driving patterns between these two categories of vehicles. (The same reasoning underlies the agencies' proposal to use the Heavy-duty FTP cycle to evaluate compliance with the standards for diesel engines used in vocational vehicles.)

The variety of vocational vehicle applications makes it challenging to establish a single cycle which is representative of all such trucks. However, in aggregate, the vocational vehicles typically operate over shorter distances and spend less time cruising at highway speeds than combination tractors. The agencies evaluated two sources for mode weightings, as detailed in draft RIA Chapter 3. The agencies are proposing the mode weightings based on the vehicle speed characteristics of single unit trucks used in EPA's MOVES model which were developed using Federal Highway Administration data to distribute vehicle miles traveled by road type.[85] The proposed weighted CO_2 and fuel consumption value consists of 37 percent of 65 mph Cruise, 21 percent of 55 mph Cruise, and 42 percent of Transient performance, which are reflected in the GEM.

(iii) Empty Weight and Payload

The total weight of the vehicle is the sum of the tractor curb weight and the payload. The agencies are proposing to specify each of these aspects of the vehicle. The agencies developed the truck curb weight inputs based on industry information developed by ICF.[86] The proposed curb weights are 10,300 pounds for the LH trucks, 13,950 pounds for the MH trucks, and 29,000 pounds for the HH trucks.

NHTSA and EPA are also proposing the following payload requirement for each regulatory category. The payloads were developed from Federal Highway statistics based on averaging the payloads for the weight categories represented within each vehicle subcategory.[87] The proposed payload requirement is 5,700 pounds for the Light Heavy-Duty trucks, 11,200 pounds for Medium Heavy-Duty trucks, and 38,000 pounds for Heavy Heavy-Duty trucks. Additional information is available in draft RIA Chapter 3.

(iv) Engine

As the agencies are proposing separate engine and truck standards, the GEM will be used to assess the compliance of the chassis with the vehicle standard. To maintain the separate assessments, the agencies are proposing to use fixed values that are pre-defined by the agencies for the engine characteristics used in GEM, including the fuel consumption map which provides the fuel consumption at hundreds of engine speed and torque points. If the agencies did not standardize the fuel map, then a truck that uses an engine with emissions and fuel consumption better than the standards would require fewer vehicle reductions than those being proposed. The agencies are proposing that the engine characteristics used in GEM be representative of a diesel engine, because it represents the largest fraction of engines in this market.

The agencies are proposing two distinct sets of fuel consumption maps for use in GEM. The first fuel consumption map would be used in GEM for the 2014 through 2016 model years and represent a diesel engine which meets the 2014 model year engine CO_2 emissions standards. A second fuel consumption map would be used beginning in the 2017 model year and represents a diesel engine which meets the 2017 model year CO_2 emissions and fuel consumption standards and accounts for the increased stringency in the proposed MY 2017 standard). Effectively there is no change in stringency of the vocational vehicle standard (not including the engine) so that there is stability in the vocational vehicle (not including engine) standards for the full rulemaking period. These inputs are reasonable (indeed, seemingly necessitated) given the separate proposed regulatory requirement that vocational vehicle chassis manufacturers use only certified engines.

(v) Drivetrain

The agencies' assessment of the current vehicle configuration process at the truck dealer's level is that the truck companies provide software tools to specify the proper drivetrain matched to the buyer's specific circumstances. These dealer tools allow a significant amount of customization for drive cycle and payload to provide the best specification for the customer. The agencies are not seeking to disrupt this process. Optimal drivetrain selection is dependent on the engine, drive cycle (including vehicle speed and road grade), and payload. Each combination of engine, drive cycle, and payload has a single optimal transmission and final drive ratio. The agencies are proposing to specify the engine's fuel consumption map, drive cycle, and payload; therefore, it makes sense to specify the drivetrain that matches.

In conclusion, for vocational vehicles, compliance would be determined by establishing values for the tire rolling resistance and using the prescribed inputs in GEM. The model would produce CO_2 and fuel consumption results that would be compared against EPA's and NHTSA's respective standards.

(d) Engine Test Procedures

The NAS panel did not specifically discuss or recommend a metric to evaluate the fuel consumption of heavy-duty engines. However, as noted above they did recommend the use of a load-specific fuel consumption metric for the

[85] The Environmental Protection Agency. Draft MOVES2009 Highway Vehicle Population and Activity Data. EPA–420–P–09–001, August 2009 *http://www.epa.gov/otaq/models/moves/techdocs/420p09001.pdf.*

[86] ICF International. "Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for Heavy-Duty On-Road Vehicles." July 2010. Pages 16–20. Docket ID# EPA–HQ–OAR–2010–0162–0044.

[87] 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.*

evaluation of vehicles.[88] An analogous metric for engines would be the amount of fuel consumed per unit of work. Thus, EPA is proposing that GHG emission standards for engines under the CAA would be expressed as g/bhp-hr: similarly, NHTSA's proposed fuel consumption standards under EISA would be represented as gallons of fuel per 100 horsepower-hour (gal/100 bhp-hr). EPA's metric is also consistent with EPA's current standards for non-GHG emissions for these engines.

EPA's criteria pollutant standards for engines currently require that manufacturers demonstrate compliance over the transient FTP cycle; over the steady-state SET procedure; and during not-to-exceed testing. EPA created this multi-layered approach to criteria emissions control in response to engine designs that optimized operation for lowest fuel consumption at the expense of very high criteria emissions when operated off the regulatory cycle. EPA's use of multiple test procedures for criteria pollutants helps to ensure that manufacturers calibrate engine systems for compliance under all operating conditions. With regard to GHG and fuel consumption control, the agencies believe it is more appropriate to set standards based on a single test procedure, either the Heavy-duty FTP or SET, depending on the primary expected use of the engine.

As discussed above, it is critical to set standards based on the most representative test cycles in order for performance in-use to obtain the intended (and feasible) air quality benefits. We further explained why the Heavy-duty FTP is the appropriate test cycle for engines used in vocational vehicles, and the steady-state SET procedure the most appropriate for engines used in combination tractors. We are not concerned if off-cycle manufacturers further calibrate these designs to give better in-use fuel consumption while maintaining compliance with the criteria emissions standards as such calibration is entirely consistent with the goals of our joint program. Further, we believe that setting standards based on both transient and steady-state operating conditions for all engines could lead to undesirable outcomes. For example, as noted earlier, turbocompounding is one technology that the agencies have identified as a likely approach for compliance with our proposed HHD SET standard described below. Turbocompounding is a very effective approach to lower fuel consumption under steady driving conditions typified by combination tractor trailer operation and is well reflected in testing over the SET test procedure. However, when used in driving typified by transient operation as we expect for vocational vehicles and as is represented by the Heavy-duty FTP, turbocompounding shows very little benefit. Setting an emission standard based on the Heavy-duty FTP for engines intended for use in combination tractor trailers could lead manufacturers to not apply turbocompounding even though it can be a highly cost effective means to reduce GHG emissions and lower fuel consumption.

The current non-GHG emissions engine test procedures also require the development of regeneration emission rates and frequency factors to account for the emission changes during a regeneration event (40 CFR 86.004–28). EPA and NHTSA are proposing to exclude the CO_2 emissions and fuel consumption increases due to regeneration from the calculation of the compliance levels over the defined test procedures. We considered including regeneration in the estimate of fuel consumption and GHG emissions and have decided not to do so for two reasons. First, EPA's existing criteria emission regulations already provide a strong motivation to engine manufacturers to reduce the frequency and duration of infrequent regeneration events. The very stringent 2010 NO_X emission standards cannot be met by engine designs that lead to frequent and extended regeneration events. Hence, we believe engine manufacturers are already reducing regeneration emissions to the greatest degree possible. In addition to believing that regenerations are already controlled to the extent technologically possible, we believe that attempting to include regeneration emissions in the standard setting could lead to an inadvertently lax emissions standard. In order to include regeneration and set appropriate standards, EPA and NHTSA would have needed to project the regeneration frequency and duration of future engine designs in the timeframe of this proposal. Such a projection would be inherently difficult to make and quite likely would underestimate the progress engine manufacturers will make in reducing infrequent regenerations. If we underestimated that progress, we would effectively be setting a more lax set of standards than otherwise would be expected. Hence in setting a standard including regeneration emissions we faced the real possibility that we would achieve less effective CO_2 emissions control and fuel consumption reductions than we will achieve by not including regeneration emissions. We are seeking comments regarding regeneration emissions and what approach if any the agencies should use in reflecting regeneration emissions in this program.

(e) Hybrid Powertrain Technology

Although the proposed vocational vehicle standards are not premised on use of hybrid powertrains, certain vocational vehicle applications may be suitable candidates for use of hybrids due to the greater frequency of stop-and-go urban operation and their use of power take-off (PTO) systems. Examples are vocational vehicles used predominantly in stop-start urban driving (*e.g.,* delivery trucks). As an incentive, the agencies are proposing to provide credits for the use of hybrid powertrain technology as described in Section IV. The agencies are proposing that any credits generated using such technologies could be applied to any heavy-duty vehicle or engine, and not be limited to the vehicle category generating the credit. Section IV below also details the proposed approach to account for the use of a hybrid powertrain when evaluating compliance with the truck standard. In general, manufacturers can derive the fuel consumption and CO_2 emissions reductions based on comparative test results using the proposed chassis testing procedures. We are proposing the same three drive cycles and cycle weightings discussed for the vocational vehicles to evaluate trucks that use hybrid powertrains to power the vehicle during motive operation (such as pickup and delivery trucks and transit buses). However, we are proposing an additional PTO test cycle for trucks which use a PTO to power equipment while the vehicle is either idling or moving (such as bucket or refuse trucks). The reductions due to the hybrid technology would be calculated relative to the same type of vehicle with a conventional powertrain tested using the same protocol.

(3) Summary of Proposed Flexibility and Credit Provisions

EPA and NHTSA are proposing a number of flexibility provisions for vocational vehicle chassis manufacturers and engine manufacturers, as discussed in Section IV below. These provisions are all based on an averaging, banking and trading program for emissions and fuel consumption credits. They include provisions to encourage the introduction of advanced technologies such as hybrid drivetrains, provisions to

[88] *See* 2010 NAS Report, Note 19, page 39.

incentivize early compliance with the proposed standards, and provisions to allow compliance using innovative technologies unanticipated by the agencies in developing this proposal.

(4) Deferral of Standards for Small Chassis Manufacturing and Small Engine Companies

EPA and NHTSA are proposing to defer greenhouse gas emissions and fuel consumption standards from small vocational vehicle chassis manufacturers meeting the SBA size criteria of a small business as described in 13 CFR 121.201 (*see* 40 CFR 1036.150 and 1037.150). The agencies will instead 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 truck and engine manufacturers.

The agencies have identified ten chassis entities that appear to fit the SBA size criterion of a small business.[89] The agencies estimate that these small entities comprise less than 0.5 percent of the total heavy-duty vocational vehicle market in the United States based on Polk Registration Data from 2003 through 2007,[90] and therefore that the exemption will have a negligible impact on the GHG emissions and fuel consumption improvements from the proposed standards.

EPA and NHTSA have also identified three engine manufacturing entities that appear to fit the SBA size criteria of a small business based on company information included in Hoover's.[91] Based on 2008 and 2009 model year engine certification data submitted to EPA for non-GHG emissions standards, the agencies estimate that these small entities comprise less than 0.1 percent of the total heavy-duty engine sales in the United States. The proposed exemption from the standards established under this proposal would have a negligible impact on the GHG emissions and fuel consumption reductions otherwise due to the standards.

To ensure that the agencies are aware of which companies would be exempt, we propose to require that such entities submit a declaration to EPA and NHTSA containing a detailed written description of how that manufacturer qualifies as a small entity under the provisions of 13 CFR 121.201.

E. Other Standards Provisions

In addition to proposing CO_2 emission standards for heavy-duty vehicles and engines, EPA is also proposing separate standards for N_2O and CH_4 emissions.[92] NHTSA is not proposing comparable separate standards for these GHGs because they are not directly related to fuel consumption in the same way that CO_2 is, and NHTSA's authority under EISA exclusively relates to fuel efficiency. N_2O and CH_4 are important GHGs that contribute to global warming, more so than CO_2 for the same amount of emissions due to their high Global Warming Potential (GWP).[93] EPA is proposing N_2O and CH_4 standards which apply to HD pickup trucks and vans as well as to all heavy-duty engines. EPA is not proposing N_2O and CH_4 standards for the Class 7 and 8 tractor or Class 2b–8 chassis manufacturers because these emissions would be controlled through the engine program.

EPA is requesting comment in Section II.E.4 below on possible alternative CO_2 equivalent approaches to provide near-term flexibility for 2012–14 MY light-duty vehicles.

Almost universally across current engine designs, both gasoline- and diesel-fueled, N_2O and CH_4 emissions are relatively low today and EPA does not believe it would be appropriate or feasible to require reductions from the levels of current gasoline and diesel engines. This is because for the most part, the same hardware and controls used by heavy-duty engines and vehicles that have been optimized for nonmethane hydrocarbon (NMHC) and NO_X control indirectly result in highly effective control of N_2O and CH_4. Additionally, unlike criteria pollutants, specific technologies beyond those presently implemented in heavy-duty vehicles to meet existing emission requirements have not surfaced that specifically target reductions in N_2O or CH_4. Because of this, reductions in N_2O or CH_4 beyond current levels in most heavy-duty applications would occur through the same mechanisms that result in NMHC and NO_X reductions and would likely result in an increase in the overall stringency of the criteria pollutant emission standards. Nevertheless, it is important that future engine technologies or fuels not currently researched do not result in increases in these emissions, and this is the intent of the proposed "cap" standards. The proposed standards would act to cap emissions at today's levels to ensure that manufacturers maintain effective N_2O and CH_4 emissions controls currently used should they choose a different technology path from what is currently used to control NMHC and NO_X but also largely successful methods for controlling N_2O and CH_4. As discussed below, some technologies that manufacturers may adopt for reasons other than reducing fuel consumption or GHG emissions could increase N_2O and CH_4 emissions if manufacturers do not address these emissions in their overall engine and aftertreatment design and development plans. Manufacturers will be able to design and develop the engines and aftertreatment to avoid such emissions increases through appropriate emission control technology selections like those already used and available today. Because EPA believes that these standards can be capped at the same level, regardless of type of HD engine involved, the following discussion relates to all types of HD engines regardless of the vehicles in which such engines are ultimately used. In addition, since these standards are designed to cap current emissions, EPA is proposing the same standards for all of the model years to which the rules apply.

EPA believes that the proposed N_2O and CH_4 cap standards would accomplish the primary goal of deterring increases in these emissions as engine and aftertreatment technologies evolve because manufacturers will continue to target current or lower N_2O and CH_4 levels in order to maintain typical compliance margins. While the cap standards are set at levels that are higher than current average emission levels, the control technologies used today are highly effective and there is no reason to believe that emissions will slip to levels close to the cap, particularly considering compliance margin targets. The caps will protect against significant increases in emissions due to new or poorly implemented technologies. However, we also believe that an alternative compliance approach that allows manufacturers to convert these emissions to CO_2eq emission values and combine them with CO_2 into a single compliance value would also be appropriate, so long as it did not undermine the stringency of the CO_2 standard. As described below, EPA is proposing that such an alternative

[89] The agencies have identified Lodal, Indiana Phoenix, Autocar LLC, HME, Giradin, Azure Dynamics, DesignLine International, Ebus, Krystal Koach, and Millenium Transit Services LLC as potential small business chassis manufacturers.

[90] M.J. Bradley. Heavy-duty Vehicle Market Analysis. May 2009.

[91] The agencies have identified Baytech Corporation, Clean Fuels USA, and BAF Technologies, Inc. as three potential small businesses.

[92] NHTSA's statutory responsibilities relating to reducing fuel consumption are directly related to reducing CO_2 emissions, but not to the control of other GHGs.

[93] N_2O has a GWP of 298 and CH_4 has a GWP of 25 according to the IPCC Fourth Assessment Report.

compliance approach be available to manufacturers to provide certain flexibilities for different technologies.

EPA requests comments on the approach to regulating N_2O and CH_4 emissions including the appropriateness of "cap" standards, the technical bases for the levels of the proposed N_2O and CH_4 standards, the proposed test procedures, and the proposed timing for the standards. In addition, EPA seeks any additional emissions data on N_2O and CH_4 from current technology engines.

EPA is basing its proposed N_2O and CH_4 standards on available test data. We are soliciting additional data, and especially data for in-use vehicles and engines that would help to better characterize changes in emissions of these pollutants throughout their useful lives, for both gasoline and diesel applications. As is typical for EPA emissions standards, we are proposing that manufacturers should establish deterioration factors to ensure compliance throughout the useful life. We are not at this time aware of deterioration mechanisms for N_2O and CH_4 that would result in large deterioration factors, but neither do we believe enough is known about these mechanisms to justify proposing assigned factors corresponding to no deterioration, as we are proposing for CO_2, or for that matter to any predetermined level. We are therefore asking for comment on this subject.

In addition to N_2O and CH_4 standards, this section also discusses air conditioning-related provisions and EPA's proposal to extend certification requirements to all-electric HD vehicles and vehicles and engines designed to run on ethanol fuel.

(1) What is EPA's proposed approach to controlling N_2O?

N_2O is a global warming gas with a GWP of 298. It accounts for about 0.3% of the current greenhouse gas emissions from heavy-duty trucks.[94]

N_2O is emitted from gasoline and diesel vehicles mainly during specific catalyst temperature conditions conducive to N_2O formation. Specifically, N_2O can be generated during periods of emission hardware warm-up when rising catalyst temperatures pass through the temperature window when N_2O formation potential is possible. For current heavy-duty gasoline engines with conventional three-way catalyst technology, N_2O is not generally produced in significant amounts because the time the catalyst spends at the critical temperatures during warm-up is short. This is largely due to the need to quickly reach the higher temperatures necessary for high catalyst efficiency to achieve emission compliance of criteria pollutants. N_2O formation is generally only a concern with diesel and potentially with future gasoline lean-burn engines with compromised NO_X emissions control systems. If the risk for N_2O formation is not factored into the design of the controls, these systems can but need not be designed in a way that emphasizes efficient NO_X control while allowing the formation of significant quantities of N_2O. However, these future advanced gasoline and diesel technologies do not inherently require N_2O formation to properly control NO_X. Pathways exist today that meet criteria emission standards that would not compromise N_2O emissions in future systems as observed in current production engine and vehicle testing[95] which would also work for future diesel and gasoline technologies. Manufacturers would need to use appropriate technologies and temperature controls during future development programs with the objective to optimize for both NO_X and N_2O control. Therefore, future designs and controls at reducing criteria emissions would need to take into account the balance of reducing these emissions with the different control approaches while also preventing inadvertent N_2O formation, much like the path taken in current heavy-duty compliant engines and vehicles. Alternatively, manufacturers who find technologies that reduce criteria or CO_2 emissions but see increases N_2O emissions beyond the cap could choose to offset N_2O emissions with reduction in CO_2 as allowed in the proposed CO_2eq option discussed in Section II.E.3.

EPA is proposing an N_2O emission standard that we believe would be met by current-technology gasoline and diesel vehicles at essentially no cost. EPA believes that heavy-duty emission standards since 2008 model year, specifically the very stringent NO_X standards for both engine and chassis certified engines, directly result in stringent N_2O control. It is believed that the current emission control technologies used to meet the stringent NO_X standards achieve the maximum feasible reductions and that no additional technologies are recognized that would result in additional N_2O reductions. As noted, N_2O formation in current catalyst systems occurs, but their emission levels are inherently low, because the time the catalyst spends at the critical temperatures during warm-up when N_2O can form is short. At the same time, we believe that the proposed standard would ensure that the design of advanced NO_X control systems for future diesel and lean-burn gasoline vehicles would control N_2O emission levels. While current NO_X control approaches used on current heavy-duty diesel vehicles do not compromise N_2O emissions and actually result in N_2O control, we believe that the proposed standards would discourage any new emission control designs for diesels or lean-burn gasoline vehicles that achieve criteria emissions compliance at the cost of increased N_2O emissions. Thus, the proposed standard would cap N_2O emission levels, with the expectation that current gasoline and diesel vehicle control approaches that comply with heavy-duty vehicle emission standards for NO_X would not increase their emission levels, and that the cap would ensure that future diesel and lean-burn gasoline vehicles with advanced NO_X controls would appropriately control their emissions of N_2O.

(a) Heavy-Duty Pickup Truck and Van N_2O Exhaust Emission Standard

EPA is proposing a per-vehicle N_2O emission standard of 0.05 g/mi, measured over the Light-duty FTP and HFET drive cycles. Similar to the CO_2 standard approach, the N_2O emission level of a vehicle would be a composite of the Light-duty FTP and HFET cycles with the same 55 percent city weighting and 45 percent highway weighting. The standard would become effective in model year 2014 for all HD pickups and vans that are subject to the proposed CO_2 emission requirements. Averaging between vehicles would not be allowed. The standard is designed to prevent increases in N_2O emissions from current levels, *i.e.,* a no-backsliding standard.

The proposed N_2O level is approximately two times the average N_2O level of current gasoline and diesel heavy-duty trucks that meet the NO_X standards effective since 2008 model year.[96] Manufacturers typically use design targets for NO_X emission levels at approximately 50% of the standard, to account for in-use emissions deterioration and normal testing and production variability, and we expect manufacturers to utilize a similar approach for N_2O emission compliance. We are not proposing a more stringent

[94] Value adapted from "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007. April 2009.

[95] Memorandum "N_2O Data from EPA Heavy-Duty Testing".

[96] Memorandum "N_2O Data from EPA Heavy-Duty Testing".

standard for current gasoline and diesel vehicles because the stringent heavy-duty NO_X standards already result in significant N_2O control, and we do not expect current N2O levels to rise for these vehicles particularly with expected manufacturer compliance margins.

Diesel heavy-duty pickup trucks and vans with advanced emission control technology are in the early stages of development and commercialization. As this segment of the vehicle market develops, the proposed N_2O standard would require manufacturers to incorporate control strategies that minimize N_2O formation. Available approaches include using electronic controls to limit catalyst conditions that might favor N_2O formation and considering different catalyst formulations. While some of these approaches may have associated costs, EPA believes that they will be small compared to the overall costs of the advanced NO_X control technologies already required to meet heavy-duty standards.

The light-duty GHG rule requires that manufacturers begin testing for N_2O by 2015 model year. The manufacturers of complete pickup trucks and vans (Ford, General Motors, and Chrysler) are already impacted by the light-duty GHG rule and will therefore have this equipment and capability in place for the timing of this proposal.

Overall, we believe that manufacturers of HD pickups and vans (both gasoline and diesel) would meet the proposed standard without implementing any significantly new technologies, only further refinement of their existing controls, and we do not expect there to be any significant costs associated with this standard.

(b) Heavy-Duty Engine N_2O Exhaust Emission Standard

EPA is also proposing a per engine N_2O emissions standard of 0.05 g/bhp-hr for heavy-duty engines which become effective in 2014 model year. These standards remain the same over the useful life of the engine. The N_2O emissions would be measured over the Heavy-duty FTP cycle because it is believed that this cycle poses the highest risk for N_2O formation versus the additional heavy-duty compliance cycles. Averaging between vehicles would not be allowed. The standard is designed to prevent increases in N_2O emissions from current levels, *i.e.,* a no-backsliding standard.

The proposed N_2O level is twice the average N_2O level of current diesel engines as demonstrated in the ACES Study and in EPA's testing of two additional engines with selective catalytic reduction aftertreatement systems.[97] Manufacturers typically use design targets for NO_X emission levels of about 50% of the standard, to account for in-use emissions deterioration and normal testing and production variability, and manufacturers are expected to utilize a similar approach for N_2O emission compliance. EPA requests comment on the agency's technical assessment of current and potential future N_2O formation in heavy-duty engines, as presented here.

Engine emissions regulations do not currently require testing for N_2O. The Mandatory GHG Reporting final rule requires reporting of N_2O and requires that manufacturers either measure N_2O or use a compliance statement based on good engineering judgment in lieu of direct N_2O measurement (74 FR 56260, October 30, 2009). The light-duty GHG final rule allows manufacturers to provide a compliance statement based on good engineering judgment through the 2014 model year, but requires measurement beginning in 2015 model year (75 FR 25324, May 7, 2010). EPA is proposing a consistent approach for heavy-duty engine manufacturers which allows them to delay direct measurement of N_2O until the 2015 model year. EPA welcomes comments on whether there are differences in the heavy-duty market which would warrant a different approach.

Manufacturers without the capability to measure N_2O by the 2015 model year would need to acquire and install appropriate measurement equipment in response to this proposed program. EPA has established four separate N_2O measurement methods, all of which are commercially available today. EPA expects that most manufacturers would use photo-acoustic measurement equipment, which EPA estimates would result in a one-time cost of about $50,000 for each test cell that would need to be upgraded.

Overall, EPA believes that manufacturers of heavy-duty engines, both gasoline and diesel, would meet the proposed standard without implementing any new technologies, and beyond relatively small facilities costs for any companies that still need to acquire and install N_2O measurement equipment, EPA does not project that manufacturers would incur significant costs associated with this proposed N_2O standard.

EPA is not proposing any vehicle-level N_2O standards for heavy-duty trucks (combination and vocational) in this proposal. The N_2O emissions would be controlled through the heavy-duty engine portion of the program. The only requirement of those truck manufacturers to comply with the N_2O requirements is to install a certified engine.

(2) What is EPA's proposed approach to controlling CH_4?

CH_4 is greenhouse gas with a GWP of 25. It accounts for about 0.03% of the greenhouse gases from heavy-duty trucks.[98]

EPA is proposing a standard that would cap CH_4 emission levels, with the expectation that current heavy-duty vehicles and engines meeting the heavy-duty emission standards would not increase their levels as explained earlier due to robust current controls and manufacturer compliance margin targets. It would ensure that emissions would be addressed if in the future there are increases in the use of natural gas or any other alternative fuel. EPA believes that current heavy-duty emission standards, specifically the NMHC standards for both engine and chassis certified engines directly result in stringent CH_4 control. It is believed that the current emission control technologies used to meet the stringent NMHC standards achieve the maximum feasible reductions and that no additional technologies are recognized that would result in additional CH_4 reductions. The level of the standard would generally be achievable through normal emission control methods already required to meet heavy-duty emission standards for hydrocarbons and EPA is therefore not attributing any cost to this part of the proposal. Since CH_4 is produced in gasoline and diesel engines similar to other hydrocarbon components, controls targeted at reducing overall NMHC levels generally also work at reducing CH_4 emissions. Therefore, for gasoline and diesel vehicles, the heavy-duty hydrocarbon standards will generally prevent increases in CH_4 emissions levels. CH_4 from heavy-duty vehicles is relatively low compared to other GHGs largely due to the high effectiveness of the current heavy-duty standards in controlling overall HC emissions.

EPA believes that this level for the standard would be met by current gasoline and diesel trucks and vans, and would prevent increases in future CH_4

[97] Coordinating Research Council Report: ACES Phase 1 of the Advanced Collaborative Emissions Study, 2009. (This study included detailed chemical characterization of exhaust species emitted from four 2007 model year heavy heavy diesel engines.)

[98] Value adapted from "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007. April 2009.

emissions in the event that alternative fueled vehicles with high methane emissions, like some past dedicated compressed natural gas vehicles, become a significant part of the vehicle fleet. Currently EPA does not have separate CH_4 standards because, unlike other hydrocarbons, CH_4 does not contribute significantly to ozone formation.[99] However, CH_4 emissions levels in the gasoline and diesel heavy-duty truck fleet have nevertheless generally been controlled by the heavy-duty HC emission standards. Even so, without an emission standard for CH_4, future emission levels of CH_4 cannot be guaranteed to remain at current levels as vehicle technologies and fuels evolve.

In recent model years, a small number of heavy-duty trucks and engines were sold that were designed for dedicated use of natural gas. While emission control designs on these recent dedicated natural gas-fueled vehicles demonstrate CH_4 control can be as effective as gasoline or diesel equivalent vehicles, natural gas-fueled vehicles have historically produced significantly higher CH_4 emissions than gasoline or diesel vehicles. This is because the fuel is predominantly methane, and most of the unburned fuel that escapes combustion without being oxidized by the catalyst is emitted as methane. However, even if these vehicles meet the heavy-duty hydrocarbon standard and appear to have effective CH_4 control by nature of the hydrocarbon controls, the heavy-duty standards do not require CH_4 control and therefore some natural gas vehicle manufacturers have invested very little effort into methane control. While the proposed CH_4 cap standard should not require any different emission control designs beyond what is already required to meet heavy-duty hydrocarbon standards on a dedicated natural gas vehicle (*i.e.*, feedback controlled 3-way catalyst), the cap will ensure that systems provide robust control of methane much like a gasoline-fueled engine. We are not proposing more stringent CH_4 standards because we believe that the controls used to meet current heavy-duty hydrocarbon standards should result in effective CH_4 control when properly implemented. Since CH_4 is already measured under the current heavy-duty emissions regulations (so that it may be subtracted to calculate NMHC), the proposed standard would not result in additional testing costs. EPA requests comment on whether the proposed cap standard would result in any significant technological challenges for manufacturers of natural gas vehicles.

(a) Heavy-Duty Pickup Truck and Van CH_4 Standard

EPA is proposing a CH_4 emission standard of 0. 05 g/mi as measured on the Light-duty FTP and HFET drive cycles, to apply beginning with model year 2014 for HD pickups and vans subject to the proposed CO_2 standards. Similar to the CO_2 standard approach, the CH_4 emission level of a vehicle would be a composite of the Light-duty FTP and HFET cycles with the same 55% city weighting and 45% highway weighting.

The level of the proposed standard is approximately two times the average heavy-duty gasoline and diesel truck and van levels.[100] As with N_2O, this proposed level recognizes that manufacturers typically set emissions design targets with a compliance margin of approximately 50% of the standard. Thus, we believe that the proposed standard should be met by current gasoline vehicles with no increase from today's CH_4 levels. Similarly, since current diesel vehicles generally have even lower CH_4 emissions than gasoline vehicles, we believe that diesels would also meet the proposed standard with a larger compliance margin resulting in no change in today's CH_4 levels.

(b) Heavy-Duty Engine CH_4 Exhaust Emission Standard

EPA is proposing a heavy-duty engine CH_4 emission standard of 0.05 g/hp-hr as measured on the Heavy-duty FTP, to apply beginning in model year 2014. The proposed standard would cap CH_4 emissions at a level currently achieved by diesel and gasoline heavy-duty engines. The level of the standard would generally be achievable through normal emission control methods already required to meet 2007 emission standards for NMHC and EPA is therefore not attributing any cost to this part of this proposal (*see* 40 CFR 86.007–11).

The level of the proposed CH_4 standard is twice the average CH_4 emissions from the four diesel engines in the ACES study.[101] As with N_2O, this proposed level recognizes that manufacturers typically set emission design targets at about 50% of the standard. Thus, EPA believes the proposed standard would be met by current diesel and gasoline engines with little if any technological improvements. The agency believes a more stringent CH_4 standard is not necessary due to effective CH_4 controls in current heavy-duty technologies, since, as discussed above for N_2O, EPA believes that the challenge of complying with the CO_2 standards should be the primary focus of the manufacturers.

CH_4 is measured under the current 2007 regulations so that it may be subtracted to calculate NMHC. Therefore EPA expects that the proposed standard would not result in additional testing costs.

EPA is not proposing any vehicle-level CH_4 standards for heavy-duty trucks (combination or vocational) in this proposal. The CH_4 emissions would be controlled through the heavy-duty engine portion of the program. The only requirement of these truck manufacturers to comply with the CH_4 requirements is to install a certified engine.

(3) Alternative CO_2 Equivalent Option

If a manufacturer is unable to meet the N_2O or CH_4 cap standards, EPA is proposing that the manufacturer may choose to comply using CO_2 credits. In other words, a manufacturer could offset any N_2O emissions or any CH_4 emissions by taking steps to further reduce CO_2. A manufacturer choosing this option would convert its measured N_2O and CH_4 test results 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.[102] By using the Global Warming Potential of N_2O and CH_4, the proposed approach recognizes the inter-correlation of these elements in impacting global warming and is environmentally neutral to meeting the proposed individual emissions caps.

The proposed NHTSA fuel consumption program will not use CO_2eq, as suggested above. Measured performance to the NHTSA fuel consumption standards will be based on the measurement of CO_2 with no adjustment for N_2O and/or CH_4. For manufacturers that use the EPA alternative CO_2eq credit, compliance to the EPA CO_2 standard will not be directly equivalent to compliance to the NHTSA fuel consumption standard.

[99] But *see Ford Motor Co.* v. *EPA*, 604 F. 2d 685 (DC Cir. 1979) (permissible for EPA to regulate CH_4 under CAA section 202(b)).

[100] Memorandum "CH_4 Data from 2010 and 2011 Heavy-Duty Vehicle Certification Tests".

[101] Coordinating Researth Council Report: ACES Phase 1 of the Advanced Collaborative Emissions Study, 2009.

[102] N_2O has a GWP of 298 and CH_4 has a GWP of 25 according to the IPCC Fourth Assessment Report.

(4) Light-Duty Vehicle N_2O and CH_4 Standards

For light-duty vehicles, as part of the MY 2012–2016 rulemaking, EPA finalized standards for N_2O and CH_4 which take effect with MY 2012. 75 FR at 25421–24. Similar to the heavy-duty standards discussed in Section II.E above, the light-duty vehicle standards for N_2O and CH_4 were established to cap emissions and prevent future emissions increases, and were generally not expected to result in the application of new technologies for current vehicle designs or significant costs for the manufacturers. EPA also finalized an alternative CO_2 equivalent standard option, which manufacturers may choose to use in lieu of complying with the otherwise-applicable N_2O and CH_4 standards. The CO_2-equivalent standard option allows manufacturers to fold all N_2O and CH_4 emissions, on a CO_2-equivalent basis, along with CO_2 into their otherwise applicable CO_2 emissions standard level. For flexible-fueled vehicles, the N_2O and CH_4 standards must be met on both fuels (*e.g.*, both gasoline and E–85).

EPA has learned since the standards were finalized that some manufacturers may have difficulty meeting the N_2O and/or CH_4 standards in the early years of the program for a few of the vehicle models in their existing fleet. This is problematic in the near-term because there is little lead time to implement unplanned redesigns of vehicles to meet the standards. In such cases, manufacturers may need to either drop vehicle models from their fleet or to comply using the CO_2 equivalent alternative. On a CO_2 equivalent basis, folding in all N_2O and CH_4 emissions would add 3–4 g/mile or more to a manufacturer's overall fleet-average CO_2 emissions level because the alternative standard must be used for the entire fleet, not just for the problem vehicles. This could be especially challenging in the early years of the program for manufacturers with little compliance margin because there is very limited lead time to develop strategies to address these additional emissions. EPA believes this poses a legitimate issue of sufficiency of lead time in the short term (as well as an issue of cost, since EPA assumed that the N_2O and CH_4 standards were essentially cost free) but expects that manufacturers would be able to make technology changes (e.g., calibration or catalyst changes) to the few vehicle models not currently meeting the N_2O and/or CH_4 standards in the course of their planned vehicle redesign schedules in order to meet the standards.

Because EPA intended for these standards to be caps with little anticipated near-term impact on manufacturer's current product lines, EPA believes that it would be appropriate to provide additional flexibility in the near-term to allow manufacturers to meet the N_2O and CH_4 standards. EPA requests comments on the option of allowing manufacturers to use the CO_2 equivalent approach for one pollutant but not the other for their fleet—that is, allowing a manufacturer to fold in either CH_4 or N_2O as part of the CO_2-equivalent standard. For example, if a manufacturer is having trouble complying with the CH_4 standard but not the N_2O standard, the manufacturer could use the N_2O equivalent option including CH_4, but choose to comply separately with the applicable N_2O cap standard. EPA requests comments on allowing this approach in the light-duty program for MYs 2012–2014 as an additional flexibility to help manufacturers address any near-term issues that they may have with the N_2O and CH_4 standards.

EPA also requests comments on possible alternative approaches of providing additional near-term flexibility. For example, as discussed in Section II.E above, EPA is proposing for HD vehicles and engines to allow manufacturers to use CO_2 credits, on a CO_2 equivalent basis, to offset N_2O and CH_4 emissions above the applicable standard. EPA requests comment on whether this approach would be appropriate for the light-duty program as an additional flexibility. Again, the additional flexibility would be limited to MYs 2012–2014 for the reasons discussed above. EPA notes that, after considering all relevant comments, provisions to address this issue may be finalized in an action independent of the heavy-duty rulemaking process in the interest of finalizing the provisions as soon as possible to provide manufacturers with certainty for MY 2012 light-duty vehicles.

(5) EPA's Proposed Standards for Direct Emissions From Air Conditioning

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.[103] This includes the direct leakage of refrigerant as well as the subsequent leakage associate with maintenance and servicing, and with disposal at the end of the vehicle's life.[104] The most commonly used refrigerant in automotive applications—R134a, has a high GWP of 1430.[105] 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.

Heavy-duty air conditioning systems today are similar to those used in light-duty applications. However, differences may exist in terms of cooling capacity (such that sleeper cabs have larger cabin volumes than day cabs), system layout (such as the number of evaporators), and the durability requirements due to longer truck life. However, the component technologies and costs to reduce direct HFC emissions are similar between the two types of vehicles.

The quantity of GHG refrigerant emissions from heavy-duty trucks relative to the CO_2 emissions from driving the vehicle and moving freight is very small. Therefore, a credit approach is not appropriate for this segment of vehicles because the value of the credit is too small to provide sufficient incentive to utilize feasible and cost-effective air conditioning leakage improvements. For the same reason, including air conditioning leakage improvements within the main standard would in many instances result in lost control opportunities. Therefore, EPA is proposing that truck manufacturers be required to meet a low leakage requirement for all air conditioning systems installed in 2014 model year and later trucks, with one exception. The agency is not proposing leakage standards for Class 2b–8 Vocational Vehicles at this time 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, with consequent difficulties in developing a regulatory system.

EPA is proposing a leakage standard which is a "percent refrigerant leakage

[103] The United States has submitted a proposal to the Montreal Protocol which, if adopted, would phase-out production and consumption of HFCs.

[104] The U.S. EPA has reclamation requirements for refrigerants in place under Title VI of the Clean Air Act.

[105] The global warming potentials used in the NPRM analysis are consistent with Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. At this time, the global warming potential values from the IPCC Second Assessment Report have been agreed upon as the official U.S. framework for addressing climate change. The global warming potential values from the IPCC Second Assessment Report are used in the official U.S. greenhouse gas inventory submission to the climate change framework. When inventories are recalculated for the final rule, changes in global warming potential may lead to adjustments.

per year" to assure that high-quality, low-leakage components are used in each air conditioning system design. The agency believes that a single "gram of refrigerant leakage per year" would not fairly address the variety of air conditioning system designs and layouts found in the heavy-duty truck sector. EPA is proposing a standard of 1.50 percent leakage per year for Heavy-duty Pickup Trucks and Vans and Class 7 and 87 and 8 Tractors. The proposed standard was derived from the vehicles with the largest system refrigerant capacity based on the Minnesota GHG Reporting database.[106] The average percent leakage per year of the 2010 model year vehicles is 2.7 percent. This proposed level of reduction is roughly comparable to that necessary to generate credits under the light-duty vehicle program. *See* 75 FR 25426–25427. Since refrigerant leakage past the compressor shaft seal is the dominant source of leakage in belt-driven air conditioning systems, the agency is seeking comment on whether the stringency of a single "percent refrigerant leakage per year" standard fairly addresses the range of system refrigerant capacities likely to be used in heavy-duty trucks.[107] Since systems with less refrigerant may have a larger percentage of their annual leakage from the compressor shaft seal than systems with more refrigerant capacity, their relative percent refrigerant leakage per year could be higher, and a more extensive application of leakage reducing technologies could be needed to meet the standard). EPA welcomes comments relative to the stringency of the standard, and on whether manufacturers who adopt measures that improve the global warming impact of leakage emissions substantially beyond that achieved by the proposed standard should in some way be credited for this improvement.

Manufacturers can choose to reduce A/C leakage emissions in two ways. First, they can utilize leak-tight components. Second, manufacturers can largely eliminate the global warming impact of leakage emissions by adopting systems that use an alternative, low-GWP refrigerant. 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 apply to 2012 model year and later vehicles. 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.[108] 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 2014. However, EPA does anticipate that updates to the SAE J2727 standard will be forthcoming (to address new materials and components which perform better than those originally used in the SAE analysis), and that it will be appropriate to include these updates in the regulations concerning refrigerant leakage.

Consistent with the 2012–2016 light-duty GHG rule, we are estimating costs for leakage control at $18 (2008$) in direct manufacturing costs. Including a low complexity indirect cost multiplier (ICM) of 1.14 results in costs of $21 in the 2014 model year. Time based learning is considered appropriate for A/C leakage control, so costs in the 2017 model year would be $19. These costs are applied to all heavy-duty pickups and vans, and to all combination tractors. 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.

EPA proposes that manufacturers demonstrate improvements in their A/C system designs and components through a design-based method. The proposed method for calculating A/C leakage 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. Under the proposed approach, manufacturers would choose from a menu of A/C equipment and components used in their vehicles in order to establish leakage scores, which would characterize their A/C system leakage performance and calculate the percent leakage per year as this score divided by the system refrigerant capacity.

Consistent with the light-duty GHG rule, EPA is proposing that a manufacturer would compare the components of its A/C system with a set of leakage-reduction technologies and actions that is based closely on that being 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. Like the cooperative industry-government program, our proposed approach would associate each component with a specific leakage rate in grams per year that is identical to the values in J2727 and then sum together the component leakage values to develop the total A/C system leakage. However, in the heavy-duty truck program, the total A/C leakage score would then be divided by the value of the total refrigerant system capacity to develop a percent leakage per year.

EPA believes that the design-based approach would result in estimates of likely leakage emissions reductions that would be comparable to those that would eventually result from performance-based testing. At the same time, comments are encouraged on all developments that may lead to a robust, practical, performance-based test for measuring A/C refrigerant leakage emissions.

CO_2 emissions are also associated with air conditioner efficiency, since air conditioners create load on the engine. *See* 74 FR 49529. However, EPA is not proposing to set air conditioning efficiency standards for vocational vehicles and combination tractors. The CO_2 emissions due to air conditioning systems in these heavy-duty trucks are minimal compared to their overall emissions of CO_2. For example, EPA conducted modeling of a Class 8 sleeper cab using GEM to evaluate the impact of air conditioning and found that it leads to approximately 1 gram of CO_2/ton-mile. Therefore, a projected 24% improvement of the air conditioning system (the level projected in the light-duty GHG rulemaking), would only reduce CO_2 emissions by less than 0.3 g CO_2/ton-mile, or approximately 0.3 percent of the baseline Class 8 sleeper cab CO_2 emissions.

EPA is not specifying 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 light-duty GHG rule, where we require that manufacturers attest to the durability of

[106] The Minnesota refrigerant leakage data can be found at *http://www.pca.state.mn.us/climatechange/mobileair.html#leakdata*.

[107] Society of Automotive Engineers Surface Vehicle Standard J2727, issued August 2008, *http://www.sae.org*.

[108] Team 1—Refrigerant Leakage Reduction: Final Report to Sponsors, SAE, 2007.

components and systems used to meet the CO_2 standards (*see* 75 FR 25689), we will require that manufacturers of heavy-duty vehicles attest to the durability of these systems, and provide an engineering analysis which demonstrates component and system durability.

(6) Indirect Emissions From Air Conditioning

As just noted, 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.

Due to the complexity of the heavy-duty market, it is difficult to estimate with any degree of precision what the actual impact of indirect emissions are across the vastly different applications and duty cycles of heavy-duty trucks. Depending on application, geographic location and even seasonal usage relationships, A/C systems usage will vary differently across the heavy-duty fleet and therefore efficiency improvements will also result in different indirect emission reductions. Moreover, as just stated, indirect A/C emissions from vocational vehicles and combination tractors are very small relative to total GHG emissions from these vehicles. For these reasons, EPA is not proposing an indirect emission standard like we have proposed for direct emissions from heavy-duty vehicles.

Instead, EPA is seeking comment on the applicability of an indirect emissions credit for A/C system efficiency improvements specifically in the heavy-duty pickup trucks and vans (*i.e.*, Class 2b and 3). These vehicles are most closely related to their light-duty counterparts that have an indirect emissions credit program established under the 2012–2016 MY Light-duty Vehicle Rule. It is likely that the light-duty and heavy-duty vehicles can share components used to improve the A/C system efficiency and reduce indirect A/C emissions. EPA also seeks comment on the level of the credit and if the fleet CO_2 target standards should be adjusted accordingly to reflect expected A/C efficiency improvements similar to the approach used in the light-duty rule.

(7) Ethanol-Fueled and Electric Vehicles

Current EPA emissions control regulations explicitly apply to heavy-duty engines and vehicles fueled by gasoline, methanol, natural gas and liquefied petroleum gas. For multi-fueled vehicles they call for compliance with requirements established for each consumed fuel. This contrasts with EPA's light-duty vehicle regulations that apply to all vehicles generally, regardless of fuel type. We are proposing to revise the heavy-duty vehicle and engine regulations to make them consistent with the light-duty vehicle approach, applying standards for all regulated criteria pollutants and GHGs regardless of fuel type, including application to all-electric vehicles (EVs). This provision would take effect in the 2014 model year, and be optional for manufacturers in earlier model years. However, to satisfy the CAA section 202(a)(3) lead time constraints, the provision would remain optional for all criteria pollutants through the 2015 model year.

This change would primarily affect manufacturers of ethanol-fueled vehicles (designed to operate on fuels containing at least 50 percent ethanol) and EVs. Flex-fueled vehicles (FFVs) designed to run on both gasoline and fuel blends with high ethanol content would also be impacted, as they would need to comply with requirements for operation both on gasoline and ethanol.

We are proposing that the specific regulatory requirements for certification on ethanol follow those already established for methanol, such as certification to NMHC equivalent standards and waiver of certain requirements. We would expect testing to be done using the same E85 test fuel as is used today for light-duty vehicle testing, an 85/15 blend of commercially-available ethanol and gasoline vehicle test fuel. EV certification would also follow light-duty precedents, primarily calling on manufacturers to exercise good engineering judgment in applying the regulatory requirements, but would not be allowed to generate NO_X or PM credits.

This proposed provision is not expected to result in any significant added burden or cost. It is already the practice of HD FFV manufacturers to voluntarily conduct emissions testing for these vehicles on E85 and submit the results as part of their certification application, along with gasoline test fuel results. No changes in certification fees are being proposed in connection with this proposed provision. We expect that there would be strong incentives for any manufacturers seeking to market these vehicles to also want them to be certified: (1) Uncertified vehicles would carry a disincentive to potential purchasers who typically have the benefit to the environment as one of their reasons for considering alternative fuels, (2) uncertified vehicles would not be eligible for the substantial credits they could likely otherwise generate, (3) EVs have no tailpipe or evaporative emissions and thus need no added hardware to put them in a certifiable configuration, and (4) emissions controls for gasoline vehicles and FFVs are also effective on dedicated ethanol-fueled vehicles, and thus costly development programs and specialized components would not be needed; in fact the highly integrated nature of modern automotive products make the emission control systems essential to reliable vehicle performance.

Regarding technological feasibility, as mentioned above, HD FFV manufacturers already test on E85 and the resulting data shows that they can meet emissions standards on this fuel. Furthermore, there is a substantial body of certification data on light-duty FFVs (for which testing on ethanol is already a requirement), showing existing emission control technology is capable of meeting even the more stringent Tier 2 standards in place for light-duty vehicles. EPA requests comment on this proposed application of its emission standards to HD vehicles and engines, regardless of the fuels they operate on.

III. Feasibility Assessments and Conclusions

In this section, NHTSA and EPA discuss several aspects of our joint technical analyses. These analyses are common to the development of each agency's proposed standards. Specifically we discuss: the development of the baseline used by each agency for assessing costs, benefits, and other impacts of the standards, the technologies the agencies evaluated and their costs and effectiveness, and the development of the proposed standards based on application of technology in light of the attribute based distinctions and related compliance measurement procedures. We also discuss consideration of standards that are either more or less stringent than those proposed.

This proposal is based on the need to obtain significant oil savings and GHG emissions reductions from the transportation sector, and the recognition that there are appropriate and cost-effective technologies to achieve such reductions feasibly. The decision on what standard to set is guided by each agency's statutory requirements, and is largely based on the need for reductions, the effectiveness of the emissions control technology, the cost and other impacts of implementing the technology, and the lead time needed for manufacturers to employ the control technology. The availability of technology to achieve reductions and the cost and other aspects of this technology are therefore a central focus of this proposed rulemaking.

Here, the focus of the standards is on applying fuel efficiency and emissions control technology to reduce fuel consumption, CO_2 and other greenhouse gases. Vehicles combust fuel to generate power that is used to perform two basic functions: (1) Transport the truck and its payload, and (2) operate various accessories during the operation of the truck such as the PTO units. Engine-based technology can reduce fuel consumption and CO_2 emissions by improving engine efficiency, which increases the amount of power produced per unit of fuel consumed. Vehicle-based technology can reduce fuel consumption and CO_2 emissions by increasing the vehicle efficiency, which reduces the amount of power demanded from the engine to perform the truck's primary functions.

Our technical work has therefore focused on both engine efficiency improvements and vehicle efficiency improvements. In addition to fuel delivery, combustion, and aftertreatment technology, any aspect of the truck that affects the need for the engine to produce power must also be considered. For example, the drag due to aerodynamics and the resistance of the tires to rolling both have major impacts on the amount of power demanded of the engine while operating the vehicle.

The large number of possible technologies to consider and the breadth of vehicle systems that are affected mean that consideration of the manufacturer's design and production process plays a major role in developing the proposed standards. Engine and vehicle manufacturers typically develop many different models based on a limited number of platforms. The platform typically consists of a common engine or truck model architecture. For example, a common engine platform may contain the same configuration (such as inline), number of cylinders, valvetrain architecture (such as overhead valve), cylinder head design, piston design, among other attributes. An engine platform may have different calibrations, such as different power ratings, and different aftertreatment control strategies, such as exhaust gas recirculation (EGR) or selective catalytic reduction (SCR). On the other hand, a common vehicle platform has different meanings depending on the market. In the heavy-duty pickup truck market, each truck manufacturer usually has only a single pickup truck platform (for example the F series by Ford) with common chassis designs and shared body panels, but with variations on load capacity of the axles, the cab configuration, tire offerings, and powertrain options. Lastly, the combination tractor market has several different platforms and the trucks within each platform (such as LoneStar by Navistar) have less commonality. Tractor manufacturers will offer several different options for bumpers, mirrors, aerodynamic fairing, wheels, and tires, among others. However, some areas such as the overall basic aerodynamic design (such as the grill, hood, windshield, and doors) of the tractor are tied to tractor platform.

The platform approach allows for efficient use of design and manufacturing resources. Given the very large investment put into designing and producing each truck model, manufacturers of heavy-duty pickup trucks and vans typically plan on a major redesign for the models every 5 years or more. Recently, EPA's non-GHG heavy-duty engine program provided new emissions standards every three model years. Heavy-duty engine and truck manufacturer product plans typically have fallen into three year cycles to reflect this regime. While the recent non-GHG emissions standards can be handled generally with redesigns of engines and trucks, a complete redesign of a new heavy-duty engine or truck typically occurs on a slower cycle and often does not align in time due to the fact that the manufacturer of engines differs from the truck manufacturer. At the redesign stage, the manufacturer will upgrade or add all of the technology and make most other changes supporting the manufacturer's plans for the next several years, including plans related to emissions, fuel efficiency, and safety regulations.

A redesign of either engine or truck platforms often involves a package of changes designed to work together to meet the various requirements and plans for the model for several model years after the redesign. This often involves significant engineering, development, manufacturing, and marketing resources to create a new product with multiple new features. In order to leverage this significant upfront investment, manufacturers plan vehicle redesigns with several model years of production in mind. Vehicle models are not completely static between redesigns as limited changes are often incorporated for each model year. This interim process is called a refresh of the vehicle and it generally does not allow for major technology changes although more minor ones can be done (*e.g.,* small aerodynamic improvements, *etc*). More major technology upgrades that affect multiple systems of the vehicle thus occur at the vehicle redesign stage and not in the time period between redesigns.

As discussed below, there are a wide variety of CO_2 and fuel consumption reducing technologies involving several different systems in the engine and vehicle that are available for consideration. Many can involve major changes to the engine or vehicle, such as changes to the engine block and cylinder heads or changes in vehicle shape to improve aerodynamic efficiency. Incorporation of such technologies during the periodic engine, transmission or vehicle redesign process would allow manufacturers to develop appropriate packages of technology upgrades that combine technologies in ways that work together and fit with the overall goals of the redesign. By synchronizing with their multi-year planning process, manufacturers can avoid the large increase in resources and costs that would occur if technology had to be added outside of the redesign process. We considered redesign cycles both in our costing and in assessing the lead time required.

As described below, the vast majority of technology required by this proposal is commercially available and already being utilized to a limited extent across the fleet. Therefore the majority of the emission and fuel consumption reductions which would result from these proposed rules would result from the increased use of these technologies. EPA and NHTSA also believe that these proposed rules would encourage the development and limited use of more advanced technologies, such as advanced aerodynamics and hybrid powertrains in some vocational vehicle applications.

In evaluating truck efficiency, NHTSA and EPA have excluded fundamental changes in the engine or trucks' performance. Put another way, none of the technology pathways underlying the proposed standards involve any alteration in vehicle utility. For example, the agencies did not consider approaches that would necessitate reductions in engine power or otherwise limit truck performance. The agencies have thus limited the assessment of technical feasibility and resultant vehicle cost to technologies which maintain freight utility.

The agencies worked together to determine component costs for each of the technologies and build up the costs accordingly. For costs, the agencies considered 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 approach utilized by the agencies in the light-duty fuel economy and GHG final rule. A bill of materials, in a general sense, is a list of components or sub-systems that make up a system—in this case, an item of technology which reduces GHG emissions and fuel consumption. In order to determine what a system costs, one of the first steps is to determine its components and what they cost. NHTSA and EPA estimated these components and their costs based on a number of sources for cost-related information. In general, the direct costs of fuel consumption-improving technologies for heavy-duty pickups and vans are consistent with those used in the 2012–2016 MY light-duty GHG rule, except that the agencies have scaled up certain costs where appropriate to accommodate the larger size and/or loads placed on parts and systems in the heavy-duty classes relative to the light-duty classes. For loose heavy-duty engines, the agencies have consulted various studies and have exercised engineering judgment when estimating direct costs. For technologies expected to be added to vocational vehicles and combination tractors, the agencies have again consulted various studies and have used engineering judgment to arrive at direct cost estimates. Once costs were determined, they were adjusted to ensure that they were all expressed in 2008 dollars using a ratio of gross domestic product deflators for the associated calendar years.

Indirect costs were accounted for using the ICM approach explained in Chapter 2 of the draft RIA, rather than using the traditional Retail Price Equivalent (RPE) multiplier approach. For the heavy-duty pickup truck and van cost projections in this proposal, the agencies have used ICMs developed for light-duty vehicles (with the exception that here return on capital has been incorporated into the ICMs, where it had not been in the light-duty rule) primarily because the manufacturers involved in this segment of the heavy-duty market are the same manufacturers that build light-duty trucks. For the Class 7 and 8 tractor, vocational vehicle, and heavy-duty engine cost projections in this proposal, EPA contracted with RTI International to update EPA's methodology for accounting for indirect costs associated with changes in direct manufacturing costs for heavy-duty engine and truck manufacturers.[109] In addition to the indirect cost multipliers varying by complexity and time frame, there is no reason to expect that the multipliers would be the same for engine manufacturers as for truck manufacturers. The report from RTI provides a description of the methodology, as well as calculations of new indirect cost multipliers. The multipliers used here include a factor of 5 percent of direct costs representing the return on capital for heavy-duty engines and truck manufacturers. These indirect cost multipliers are intended to be used, along with calculations of direct manufacturing costs, to provide improved estimates of the full additional costs associated with new technologies.

Details of the direct and indirect costs, and all applicable ICMs, are presented in Chapter 2 of the draft RIA. In addition, for details on the ICMs, please refer to the RTI report that has been placed in the docket. The agencies request comment on all aspects of the cost analysis, including the adjustment factors used in the RTI analysis—the levels associated with R&D, warranty, *etc.*—and whether those are appropriate or should be revised. If commenters suggest revisions, the agencies request supporting arguments and/or documentation.

EPA and NHTSA believe that the emissions reductions called for by the proposed standards are technologically feasible at reasonable costs within the lead time provided by the proposed standards, reflecting our projections of widespread use of commercially available technology. Manufacturers may also find additional means to reduce emissions and lower fuel consumption beyond the technical approaches we describe here. We encourage such innovation through provisions in our flexibility program as discussed in Section IV.

The agencies request comment on the methods and assumptions used to estimate costs, benefits, and technology cost-effectiveness for the main proposal and all of the alternatives. The agencies also seek comment on whether finalizing a different alternative stringency level for certain regulatory categories would be appropriate given agency estimates of costs and benefits.

The remainder of this section describes the technical feasibility and cost analysis in greater detail. Further detail on all of these issues can be found in the joint draft RIA Chapter 2.

A. Class 7–8 Combination Tractor

Class 7 and 8 tractors are used in combination with trailers to transport freight.[110] The variation in the design of these tractors and their typical uses drive different technology solutions for each regulatory subcategory.

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 recent National Academy of Sciences report of Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,[111] TIAX's assessment of technologies to support the NAS panel report,[112] EPA's Heavy-duty Lumped Parameter Model,[113] the analysis conducted by the Northeast States Center for a Clean Air Future, International Council on Clean Transport, Southwest Research Institute and TIAX for reducing fuel consumption of heavy-duty long haul combination tractors (the NESCCAF/ICCT study),[114] and the technology cost analysis conducted by ICF for EPA.[115] Following on the EISA of 2007, the National Research Council appointed a NAS committee to assess technologies for improving fuel efficiency of heavy-duty vehicles to support NHTSA's rulemaking. The 2010 NAS report assessed current and future technologies for reducing fuel consumption, how the technologies could be implemented, and

[109] RTI International. Heavy-duty Truck Retail Price Equivalent and Indirect Cost Multipliers. July 2010.

[110] "Tractor" is defined in proposed section 1037.801 to mean "a vehicle capable of pulling trailers that is not intended to carry significant cargo other than cargo in the trailer, or any other vehicle intended for the primary purpose of pulling a trailer."

[111] 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*.

[112] TIAX, LLC. Assessment of Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles. November 2009.

[113] U.S. EPA. Heavy-duty Lumped Parameter Model.

[114] NESCCAF, ICCT, Southwest Research Institute, and TIAX. Reducing Heavy-Duty Long Haul Combination Truck Fuel Consumption and CO_2 Emissions. October 2009.

[115] 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–2010–0162–0044.

identified the potential cost of such technologies. The NAS panel contracted TIAX to perform an assessment of technologies and their associated capital costs which provide potential fuel consumption reductions in heavy-duty trucks and engines. Similar to the Lumped Parameter model which EPA developed to assess the impact and interactions of GHG and fuel consumption reducing technologies for light-duty vehicles, EPA developed a new version to specifically address the effectiveness and interactions of the proposed pickup truck and light heavy-duty engine technologies. The NESCAFF/ICCT study assessed technologies available in the 2012 through 2017 to reduce CO_2 emissions and fuel consumption of line haul combination tractors and trailers. Lastly, the ICF report focused on the capital, maintenance, and operating costs of technologies currently available to reduce CO_2 emissions and fuel consumption in heavy-duty engines, combination tractors, and vocational vehicles.

(1) What technologies did the agencies consider to reduce the CO_2 emissions and fuel consumption of tractors?

Manufacturers can reduce CO_2 emissions and fuel consumption of combination tractors through use of, among others, engine, aerodynamic, tire, extended idle, and weight reduction technologies. The standards are premised on use of these technologies. The agencies note that SmartWay trucks are available today which incorporate the technologies that the agencies are considering as the basis for the standards in this proposal. 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 the baseline tractor and engine technologies for the 2010 model year, and then discuss the kinds of technologies that could be used to improve performance relative to this baseline.

(a) Baseline Tractor & Tractor Technologies

Baseline tractor: The agencies developed the baseline tractor to represent the average 2010 model year tractor. Today there is a large spread in aerodynamics in the new tractor fleet. Trucks sold may reflect classic styling, or may be sold with conventional or SmartWay aerodynamic packages. Based on our review of current truck model configurations and Polk data provided through MJ Bradley,[116] we believe the aerodynamic configuration of the baseline new truck fleet is approximately 25 percent classic, 70 percent conventional, and 5 percent SmartWay (as these configurations are explained above in Section II.B. (2)(c)). The baseline Class 7 and 8 day cab tractor consists of an aerodynamic package which closely resembles the "conventional" package described in Section II.B. (2)(c), baseline tire rolling resistance of 7.8 kg/metric ton for the steer tire and 8.2 kg/metric ton,[117] dual tires with steel wheels on the drive axles, and no vehicle speed limiter. The baseline tractor for the Class 8 sleeper cabs contains the same aerodynamic and tire rolling resistance technologies as the baseline day cab, does not include vehicle speed limiters, and does not include an idle reduction technology. The agencies assume the baseline transmission is a 10 speed manual.

Performance from this baseline can be improved by the use of the following technologies:

Aerodynamic technologies: There are opportunities to reduce aerodynamic drag from the tractor, but it is 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. As discussed in the TIAX report, the coefficient of drag (Cd) of a SmartWay sleeper cab high roof tractor is approximately 0.60, which is a significant improvement over a truck with no aerodynamic features which has a Cd value of approximately 0.80.[118] The GEM demonstrates that an aerodynamic improvement of a Class 8 high roof sleeper cab with a Cd value from 0.60 (which represents a SmartWay tractor) provides a 5% reduction in fuel consumption and CO_2 emissions over a truck with a Cd of 0.68.

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% have been identified for tires designed to equip the same vehicle. The baseline rolling resistance coefficient for today's fleet is 7.8 kg/metric ton for the steer tire and 8.2 kg/metric ton for the drive tire, based on sales weighting of the top three manufacturers based on market share.[119] Since 2007, SmartWay trucks 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.[120] Low rolling resistance (LRR) drive tires are currently offered in both dual assembly and single wide-base configurations. Single wide tires can offer both the rolling resistance reduction along with improved aerodynamics and weight reduction. The GEM demonstrates that replacing baseline tractor tires with tires which meet the SmartWay level provides a 4% reduction in fuel consumption and CO_2 emissions over the prescribed test cycle.

Weight Reduction: Reductions in vehicle mass reduce fuel consumption and GHGs by reducing the overall vehicle mass to be accelerated and also through increased vehicle payloads which can allow additional tons to be carried by fewer trucks consuming less fuel and producing lower emissions on a ton-mile basis. Initially, the agencies considered evaluating vehicle mass reductions on a total vehicle basis for tractors and vocational trucks.[121] The agencies considered defining a baseline vehicle curb weight and the GEM model would have used the vehicle's actual curb weight to calculate the increase or decrease in fuel consumption related to the overall vehicle mass relative to that baseline. After considerable evaluation

[116] MJ Bradley. Heavy-duty Market Analysis. May 2009. Page 10.

[117] US Environmental Protection Agency. *SmartWay Transport Partnership July 2010 e-update* accessed July 16, 2010, from *http://www.epa.gov/smartwaylogistics/newsroom/documents/e-update-july-10.pdf.*

[118] TIAX. "Assessment of Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles", TIAX LLC, November 19, 2009. Page 4–50.

[119] *See* SmartWay, Note 117, above.

[120] *Ibid.*

[121] The agencies are using the approach of evaluating total vehicle mass for heavy-duty pickups and vans. where we have more data on the current fleet vehicle mass.

of this issue, including discussions with the industry, we decided it would not be possible to define a single vehicle baseline mass for the tractors and for vocational trucks that would be appropriate and representative. Actual vehicle curb weights for these classes of vehicles vary by thousands of pounds dependent on customer features added to vehicles and critical to the function of the vehicle in the particular vocation in which it is used. This is true of vehicles such as Class 8 tractors considered in this section that may appear to be relatively homogenous but which in fact are quite heterogeneous.

This reality led us to the solution we are proposing. We reflect mass reductions for specific technology substitutions (*e.g.,* installing aluminum wheels instead of steel wheels) where we can with confidence verify the mass reduction information provided by the manufacturer even though we cannot estimate the actual curb weight of the vehicle. In this way, we are accounting for mass reductions where we can accurately account for its benefits. In the future, if we are able to develop an appropriate vehicle mass baseline for the diversity of vehicles within a segment and therefore could reasonable project overall mass reductions that would not inadvertently reduce customer utility, we would consider setting standards that take into account overall vehicle mass reductions. The agencies' baseline tire and wheel package consists of dual tires with steel wheels. A tractor's empty curb weight can be reduced from the replacement of dual tires with single wide tires and with the replacement of steel wheels with high strength steel or aluminum. Analysis of literature indicates that there is opportunity to reduce typical tractor curb weights by 80 to 670 pounds, or up to roughly 3 percent, through the use of lighter weight wheels and single wide tires, as described in draft RIA Chapter 2. High strength steel, aluminum, and light weight aluminum alloys provide opportunities to reduce the truck's mass relative to steel wheels. In addition, single wide tires (a single wide-based tire which replaces two standard tires in each wheel position) provide the opportunity to reduce the overall mass of wheels and tires due to the replacement of dual tires with singles. On average, these technologies together can reduce weight by over 400 pounds. A weight reduction of this magnitude applied to a truck which travels at 70,000 pounds will have a minimal impact on fuel consumption. However, for trucks which operate at the maximum GVWR which occurs approximately for one third of truck miles travelled, a reduced tare weight will allow for additional payload to be carried. The GEM demonstrates that a weight reduction of 400 pounds applied to the payload tons for one third of the trips provides a 0.3 percent reduction in fuel consumption and CO_2 emissions over the prescribed test cycle.

Extended Idle Reduction: Auxiliary power units (APU)s, 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 the baseline 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.[122] EPA and NHTSA agree with the TIAX assessment of a 6 percent reduction in overall fuel consumption reduction.[123]

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, which limits the vehicle's maximum speed, is a simple technology that is utilized today by some fleets (though the typical maximum speed setting is often higher than 65 mph). The GEM shows that using a vehicle speed limiter set at 62 mph will provide a 4 percent reduction in fuel consumption and CO_2 emissions over the prescribed test cycles over a baseline vehicle without a VSL or one set above 65 mph.

Transmission: As discussed in the 2010 NAS report, automatic and automated manual transmissions may offer the ability to improve vehicle fuel consumption by optimizing gear selection compared to an average driver. 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.[124] 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 an automatic transmission can not 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. While we believe there may be real benefits in reduced fuel consumption and GHG emissions through the application of automatic or automated manual transmission technology, we are not proposing to reflect that potential improvement in our standard setting nor in our compliance model. We have taken this approach because we cannot say with confidence what level of performance improvement to expect. However, we welcome comments on this decision supported where possible with data. If a clear measure of performance improvement can be defined for the use of automatic or automated manual transmission technologies, we will consider reflecting the technology in setting the stringency of the standards and in determining compliance with the standards.

Low Friction Transmission, Axle, and Wheel Bearing Lubricants: The 2010 NAS report assessed low friction lubricants for the drivetrain as a 1 percent improvement in fuel consumption based on fleet testing.[125] The light-duty fuel economy and GHG final 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. However, it is not clear if in many heavy-duty applications these low friction lubricants could have competing requirements like component durability issues requiring specific lubricants with different properties than low friction. The agencies are interested in comments on whether low friction lubricants should be included in the technologies modeled in GEM to obtain certification values for fuel consumption and CO_2 emissions and how manufacturers could ensure the use of these lubricants for the full useful life of the truck.

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, which are already included as a separate technology in the agencies' technology assessment. NAS estimated that hybrid systems would cost approximately $25,000 per truck in the 2015 through 2020 timeframe and

[122] *See* the draft RIA Chapter 2 for details.

[123] *See* the 2010 NAS Report, Note 111, above, at 128.

[124] *See* TIAX, Note 112, above at 4–70.

[125] *See* the 2010 NAS Report, Note 111, page 67.

provide a potential fuel consumption reduction of 10 percent, of which 6 percent is idle reduction which can be achieved through other idle reduction technologies.[126] 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 proposal, the agencies are not including hybrids in assessing standard stringency (or as an input to GEM). However as discussed in Section IV, the agencies are providing incentives to encourage the introduction of advanced technologies including hybrid powertrains in appropriate applications.

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.

(b) Baseline Engine & Engine Technologies

The baseline engine for the Class 8 tractors is a Heavy Heavy-Duty Diesel engine with 15 liters of displacement which produces 455 horsepower. The agencies are using a smaller baseline engine for the Class 7 tractors because of the lower combined weights of this class of vehicles require less power, thus the baseline is an 11L engine with 350 horsepower. The agencies developed the baseline diesel engine as a 2010 model year engine with an aftertreatment system which meets EPA's 0.2 grams of NOX/bhp-hr standard with an SCR system along with EGR and meets the PM emissions standard with a diesel particulate filter with active regeneration. The baseline engine is turbocharged with a variable geometry turbocharger. The following discussion of technologies describes improvements over the 2010 model year baseline engine performance, unless otherwise noted. Further discussion of the baseline engine and its performance can be found in Section III.A.2.6 below.

Engine performance for CO2 emissions and fuel consumption can be improved by use of the following technologies:

Turbochargers: Improved efficiency of a turbocharger compressor or turbine could reduce fuel consumption by approximately 1 to 2 percent over variable geometry turbochargers in the market today.[127] The 2010 NAS report identified technologies such as higher pressure ratio radial compressors, axial compressors, and dual stage turbochargers as design paths to improve turbocharger efficiency.

Low Temperature Exhaust Gas Recirculation: Most medium- and heavy-duty vehicle diesel engines sold in the U.S. market today use cooled EGR, in which part of the exhaust gas is routed through a cooler (rejecting energy to the engine coolant) before being returned to the engine intake manifold. EGR is a technology employed to reduce peak combustion temperatures and thus NOX. Low-temperature EGR uses a larger or secondary EGR cooler to achieve lower intake charge temperatures, which tend to further reduce NOX formation. If the NOX requirement is unchanged, low-temperature EGR can allow changes such as more advanced injection timing that will increase engine efficiency slightly more than 1 percent.[128] Because low-temperature EGR reduces the engine's exhaust temperature, it may not be compatible with exhaust energy recovery systems such as turbocompounding or a bottoming cycle.

Engine Friction Reduction: Reduced friction in bearings, valve trains, and the piston-to-liner interface will improve efficiency. Any friction reduction must be carefully developed to avoid issues with durability or performance capability. Estimates of fuel consumption improvements due to reduced friction range from 0.5 to 1.5 percent.[129]

Selective catalytic reduction: This technology is common on 2010 the medium- and heavy-duty diesel engines used in Class 7 and 8 tractors (and the agencies therefore are considering it as part of the baseline engine, as noted above). Because SCR is a highly effective NO_X aftertreatment approach, it enables engines to be optimized to maximize fuel efficiency, rather than minimize engine-out NO_X. 2010 SCR systems are estimated to result in improved engine efficiency of approximately 3 to 5 percent compared to a 2007 in-cylinder EGR-based emissions system and by an even greater percentage compared to 2010 in-cylinder approaches.[130] As more effective low-temperature catalysts are developed, the NOX conversion efficiency of the SCR system will increase. Next-generation SCR systems could then enable additional efficiency improvements; alternatively, these advances could be used to maintain efficiency while down-sizing the aftertreatment. We estimate that continued optimization of the catalyst could offer 1 to 2 percent reduction in fuel use over 2010 model year systems in the 2014 model year.[131] The agencies estimate an additional 1 to 2 percent reduction may be feasible in the 2017 model year through additional refinement.

Improved Combustion Process: Fuel consumption reductions in the range of 1 to 3 percent over the baseline diesel engine are identified in the 2010 NAS report through improved combustion chamber design, higher fuel injection pressure, improved injection shaping and timing, and higher peak cylinder pressures.[132]

Reduced Parasitic Loads: 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

[126] *See* the 2010 NAS Report, Note 111, page 128.

[127] TIAX Assessment of Fuel Economy Technologies for Medium and Heavy-duty Vehicles, Report to National Academy of Sciences, Nov 19, 2009, Page 4–2.

[128] TIAX Assessment of Fuel Economy Technologies for Medium and Heavy-duty Vehicles, Report to National Academy of Sciences, Nov 19, 2009, Page 4–13.

[129] TIAX, Assessment of Fuel Economy Technologies for Medium- and Heavy-duty Vehicles, Final Report, Nov. 19, 2009, pg 4–15.

[130] Stanton, D. "Advanced Diesel Engine Technology Development for High Efficiency, Clean Combustion." Cummins, Inc. Annual Progress Report 2008 Vehicle Technologies Program: Advanced Combustion Engine Technologies, US Department of Energy. Pp 113–116. December 2008.

[131] TIAX Assessment of Fuel Economy Technologies for Medium and Heavy-duty Vehicles, Report to National Academy of Sciences, Nov 19, 2009, pg. 4–9.

[132] TIAX. Assessment of Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles. November 2009. Page 4–13.

speed, which can reduce power consumption. 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.[133]

Mechanical Turbocompounding: Mechanical turbocompounding adds a low pressure power turbine to the exhaust stream in order to extract additional energy, which is then delivered to the crankshaft. Published information on the fuel consumption reduction from mechanical turbocompounding varies between 2.5 and 5 percent.[134] Some of these differences may depend on the operating condition or duty cycle that was considered by the different researchers. The performance of a turbocompounding system tends to be highest at full load and much less or even zero at light load.

Electric Turbocompounding: This approach is similar in concept to mechanical turbocompounding, except that the power turbine drives an electrical generator. The electricity produced can be used to power an electrical motor supplementing the engine output, to power electrified accessories, or to charge a hybrid system battery. None of these systems have been demonstrated commercially, but modeled results by industry and DOE have shown improvements of 3 to 5 percent.[135]

Bottoming Cycle: An engine with bottoming cycle uses exhaust or other heat energy from the engine to create power without the use of additional fuel. The sources of energy include the exhaust, EGR, charge air, and coolant. The estimates for fuel consumption reduction range up to 10 percent as documented in the 2010 NAS report.[136] However, none of the bottoming cycle or Rankine engine systems has been demonstrated commercially and are currently in only the research stage.

(2) Projected Technology Package Effectiveness and Cost

(a) Class 7 and 8 Combination Tractors

EPA and NHTSA project that CO_2 emissions and fuel consumption reductions can be feasibly and cost-effectively achieved in these rules' timeframes through the increased application of aerodynamic technologies, LRR tires, weight reduction, extended idle reduction technologies, vehicle speed limiters, and engine improvements. As discussed above, the agencies believe that hybrid powertrains in tractors will not be cost-effective in the time frame of the rules. The agencies also are not proposing to include drivetrain technologies in the standard setting process, as discussed in Section II.

The agencies evaluated each technology and estimated the most appropriate application rate of technology into each tractor subcategory. The next sections describe the effectiveness of the individual technologies, the costs of the technologies, the projected application rates of the technologies into the regulatory subcategories, and finally the derivation of the proposed standards.

(i) Baseline Tractor Performance

The agencies developed the baseline tractor for each subcategory to represent an average 2010 model year tractor configured as noted earlier. The approach taken by the agencies was to define the individual inputs to GEM. For example, the agencies evaluated the industry's tractor offerings and concluded that the average tractor contains a generally aerodynamic shape (such as roof fairings) and avoids classic features such as exhaust stacks at the B-pillar, which increase drag. The agencies consider a baseline truck as having "conventional" aerodynamic package, though today there is a large spread in aerodynamics in the new tractor fleet. As noted earlier, our assessment of the baseline new truck fleet aerodynamics represents approximately 25 percent classic, 70 percent conventional, and 5 percent SmartWay. This mix of vehicle aerodynamics provides a Cd performance level slightly greater than the "conventional aerodynamic package" Cd value (for example the baseline high roof tractor has a Cd of 0.69 while the same tractor category with a conventional aerodynamic package has a Cd of 0.68). The baseline rolling resistance coefficient for today's fleet is 7.8 kg/metric ton for the steer tire and 8.2 kg/metric ton for the drive tire, based on sales weighting of the top three manufacturers based on market share.[137] The agencies use the inputs described in GEM to derive the baseline CO_2 emissions and fuel consumption of Class 7 and 8 tractors. The results are included in Table III–2.

[133] TIAX. November 2009. Page 3–5.

[134] NESCCAF/ICCT study (p. 54) and TIAX (2009, pp. 3–5).

[135] K. G. Duleep of Energy and Environmental Analysis, R. Kruiswyk, 2008, pp. 212–214, NESCCAF/ICCT, 2009, p. 54.

[136] *See* 2010 NAS Report, Note 111, page 57.

[137] U.S. Environmental Protection Agency. SmartWay Transport Partnership July 2010 e-update accessed July 16, 2010, from *http://www.epa.gov/smartwaylogistics/newsroom/documents/e-update-july-10.pdf*.

Table III-1: Baseline Tractor Definitions

	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
Aerodynamics (Cd)							
Frontal Area (m^2)	6.0	9.8	6.0	9.8	6.0	7.7	9.8
Baseline	0.81	0.69	0.81	0.69	0.81	0.76	0.69
Steer Tires (Crr kg/metric ton)							
Baseline	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Drive Tires (Crr kg/metric ton)							
Baseline	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Weight Reduction (lb)							
Baseline	0	0	0	0	0	0	0
Extended Idle Reduction (gram CO_2/ton-mile reduction)							
Baseline	N/A	N/A	N/A	N/A	0	0	0
Vehicle Speed Limiter							
Baseline	--	--	--	--	--	--	--
Engine							
Baseline	2010 MY 11 L Engine	2010 MY 11 L Engine	2010 MY 15 L Engine	2010 MY 15 L Engine	2010 MY 15 L Engine	2010 MY 15 L Engine	2010 MY 15 L Engine

Table III-2: Class 7 and 8 Tractor Baseline CO_2 Emissions and Fuel Consumption

	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
CO_2 (grams CO_2/ton-mile)	111	130	84	96	76	81	89
Fuel Consumption (gal/1,000 ton-mile)	11.0	12.8	8.3	9.4	7.4	8.0	8.7

(ii) Tractor Technology Package Effectiveness

The agencies' assessment of the proposed technology effectiveness was developed through the use of the GEM in coordination with chassis testing of three SmartWay certified Class 8 sleeper cabs. The agencies developed technology performance characteristics for each subcategory, described below. Each technology consists of an input parameter which is in turn modeled in GEM. Table III–3 describes our proposed model inputs for the range of Class 7 and 8 tractor aerodynamic packages and vehicle technologies. This was combined with a projected technology application rate to determine the stringency of the proposed standard.

The aerodynamic packages are categorized as Classic, Conventional, SmartWay, Advanced SmartWay, and Advanced SmartWay II. The Classic aerodynamic package refers to traditional styling such as a flat front, exposed air cleaners and exhaust stacks, among others. The conventional package refers to an overall aerodynamic appearance and best represents the aerodynamics of the majority of new tractor sales. The SmartWay aerodynamic package includes technologies such as roof fairings, aerodynamic hoods, aerodynamic mirrors, chassis fairings, and cab extenders. The Advanced SmartWay and Advanced SmartWay II packages reflect different degrees of new aerodynamic technology development such as active air management. A more complete description of these aerodynamic packages is included in Chapter 2 of the draft RIA. In general, the coefficient of drag values for each package and tractor subcategory were developed from EPA's coastdown testing of tractor-trailer combinations, the 2010 NAS report, and SAE papers.

The rolling resistance coefficient for the tires was developed from SmartWay's tire testing to develop the SmartWay certification. The benefits for the extended idle reductions were developed from literature, SmartWay work, and the 2010 NAS report. The weight reductions were developed from manufacturer information.

Table III-3: Class 7 and 8 Tractor Technology Values

	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
Aerodynamics (Cd)							
Frontal Area (m^2)	6.0	9.8	6.0	9.8	6.0	7.7	9.8
Classic	0.85	0.75	0.85	0.75	0.85	0.80	0.75
Conventional	0.80	0.68	0.80	0.68	0.80	0.75	0.68
SmartWay	0.75	0.60	0.75	0.60	0.75	0.70	0.60
Advanced SmartWay	0.70	0.55	0.70	0.55	0.70	0.65	0.55
Advanced SmartWay II	0.65	0.50	0.65	0.50	0.65	0.60	0.50
Steer Tires (Crr kg/metric ton)							
Baseline	7.8	7.8	7.8	7.8	7.8	7.8	7.8
SmartWay	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Advanced SmartWay	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Drive Tires (Crr kg/metric ton)							
Baseline	8.2	8.2	8.2	8.2	8.2	8.2	8.2
SmartWay	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Advanced SmartWay	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Weight Reduction (lb)							
Control	400	400	400	400	400	400	400
Extended Idle Reduction (gram CO_2/ton-mile reduction)							
Control	N/A	N/A	N/A	N/A	5	5	5
Vehicle Speed Limiter[138]							
Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(iii) Tractor Technology Application Rates

As explained above, vehicle 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 application used to develop the proposed standards, NHTSA and EPA established technology application 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, idle reduction technologies are limited to Class 8 sleeper cabs using the assumption that day cabs are not used for overnight hoteling. A second type of constraint was applied to most other technologies and limited their application 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, and vehicle speed limiter technologies. Table III–4 specifies the application rates that EPA and NHTSA used to develop the proposed standards.

The impact of aerodynamics on a truck's efficiency increases with vehicle speed. Therefore, the usage pattern of the truck 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 truck model. The 2010 NAS Report on heavy-duty trucks found that manufacturers indicated 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.[139] EPA and NHTSA are proposing that the aerodynamic application rate for Class 8 sleeper cab high roof cabs (i.e., the degree of technology application on which the stringency of the proposed standard is premised) to consist of 20 percent of Advanced SmartWay, 70 percent SmartWay, and 10 percent conventional reflecting our assessment of the fraction of tractors in this segment that can

[138] Vehicle speed limiters are an applicable technology or all Class 7 and 8 tractors, however the standards are not premised on the use of this technology.

[139] TIAX. Assessment of Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles. November 2009. Page 4–40.

successfully apply these aerodynamic packages. The small percentage of conventional truck aerodynamics reflects applications including tractors serving as refuse haulers which spend a portion of their time off-road at the landfill and generally operate at lower speeds with frequent stops—further reducing the benefit of aggressive aerodynamic technologies. Features such as chassis skirts are prone to damage in off-road applications; therefore we are not proposing standards that are based on all trucks having chassis skirts or achieving GHG reductions premised on use of such technology. The 90 percent of tractors that we project can either be SmartWay or Advanced SmartWay equipped reflects the bulk of Class 8 high roof sleeper cab applications. We are not projecting a higher fraction of Advanced SmartWay aerodynamic systems because of the limited lead time for the program and the need for these more advanced technologies to be developed and demonstrated before being applied across a wider fraction of the fleet. Our averaging, banking and trading provisions provide manufacturers with the flexibility to implement these technologies over time even though the standard changes in a single step. We request comment on our assessment of the potential for use of Advanced SmartWay technologies and the need for a fraction of these vehicles to continue to remain configured as conventional cabs due to their occasional use off-road.

The proposed aerodynamic application for the other tractor regulatory categories is less aggressive than for the Class 8 sleeper cab high roof. The agencies recognize that there are truck 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.[140] 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 application of SmartWay technologies for all of the tractor regulatory subcategories.

Trucks designed for on/off-road application may be restricted in the ability to improve the aerodynamic design of the bumper, chassis skirts, air cleaners, and other aspects of the truck which would typically be needed to move a conventional truck into the SmartWay bin. First, off-road applications may require the use of steel bumpers which tend to be less aerodynamic than plastic designs. Second, ground clearance may be an issue for some off road applications due to poor road surface quality. This may pose a greater likelihood that those items such as chassis skirts would incur damage in use and therefore would not be a technology desirable in these applications. Third, the trucks used in off-road applications may also experience dust which requires an additional air cleaner to manage the dirt. Fourth, some trucks are used in applications which require heavier load capacity, such as those with gross combined weights of greater than 80,000 pounds, which is today's Federal highway limit. Often these trucks are configured with different axle combinations than those traditionally used on-road. These trucks may contain either a lift axle or spread axle which allows for greater carrying capability. Both of these configurations limit the design and effectiveness of chassis skirts. Lastly, some work trucks require the use of PTO operation or access to equipment which may limit the application of side extenders and chassis skirts.

The agencies considered the on/off-road restriction to aerodynamic technology application, used VIUS estimate of approximately 35 percent of tractors may be used in this type of application, and used confidential data provided by truck manufacturers regarding the fraction of their current sales which go into the various applications, to project the aerodynamic application rates for each tractor category. For example, the agencies project that day cabs with low roofs will be used more often in these on/off-road applications than day cabs with high roof. Therefore, the agencies project technology application rate for conventional aerodynamics in day cab low roof as 40 percent while it would be 30 percent in day cab high roofs tractors. The agencies have also estimated that the development of advanced aerodynamic technologies would be applied first to high roof sleeper cabs and then follow with the other tractor categories. Therefore, the agencies propose to use a 10 percent application rate of the Advanced SmartWay aerodynamic technology package to the other tractor categories. The agencies welcome comment on our assessment of application rates and are interested in data that provide estimates on truck sales to the various applications where aerodynamics are less effective or restricted.

At least one LRR tire model is available today that meets the rolling resistance requirements of the SmartWay and Advanced SmartWay tire packages so the 2014 MY should afford manufacturers sufficient lead time to install these packages. However, tire rolling resistance is only one of 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 LRR tires in all tractor segments. The agencies are proposing to base their analyses on application rates that vary by category and match the application rates used for the aerodynamic packages to reflect the on/off-road application of some tractors which require a different balancing of traction versus rolling resistance. We believe on- versus off-road traction (primarily tread pattern) is the only tire performance parameter which trades off with tire rolling resistance so significantly that tire manufacturers would be unable to develop tires meeting both the assumed lower rolling resistance performance while maintaining or improving other characteristics of tire performance. We seek comment on our assessment.

Weight reductions can be achieved through single wide tires replacing dual tires and lighter weight wheel material. Single wide tires can reduce weight by over 160 pounds per axle. Aluminum wheels used in lieu of steel wheels will reduce weight by over 80 pounds for a dual wheel axle. Light weight aluminum steer wheels and aluminum single wide drive wheels and tires package available today would provide a 670 pound weight reduction over the baseline steel steer and dual drive wheels. The

[140] U.S. Department of Energy. *Transportation Energy Data Book,* Edition 28–2009. Table 5.7.

agencies recognize that not all tractors can or will use single wide tires, and therefore are proposing a weight reduction package of 400 pounds. The agencies are proposing to use a 100 percent application rate for this weight reduction package. The agencies are unaware of reasons why a combination of lower weight wheels or tires cannot be applied to all combination tractors, but welcome comments.

Idle reduction technologies provide significant reductions in fuel consumption and CO_2 emissions for Class 8 sleeper cabs and are available on the market today, and therefore will be available in the 2014 model year. 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 while providing certainty that the overnight idle operations will be eliminated. Therefore, we are allowing the installation of only an automatic engine shutoff, without override capability, to qualify for idle emission reductions in GEM to allow for aftermarket installations of idle reduction technology. We are proposing a 100 percent application rate for this technology for Class 8 sleeper cabs (note that the current fleet is estimated to have a 30 percent application rate). The agencies are unaware of reasons why extended idle reduction technologies could not be applied to all tractors with a sleeper cab, but welcome comments.

Vehicle speed limiters may be used as a technology to meet the standard, but in setting the standard we assumed a 0 percent application rate of vehicles speed limiters. Although we believe vehicles 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 trucks 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. 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 customer. The resulting truck modeled in GEM could meet our proposed emission standard without the use of any specialized aerodynamic fairings. The resulting truck would be optimized for its intended application and would be fully compliant with our program all at a lower cost to the ultimate truck purchaser. We are seeking comment on the use of VSLs that cannot be overridden by the end-user as a means of compliance with our proposed standards.

We have chosen not to assume the use of a mandatory vehicle speed limiter in our proposal because of concerns about how to set a realistic application rate that avoids unintended adverse impacts. Although we expect there will 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. However, 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. Setting a mandatory expected use of such VSL carries the risk of requiring VSL in situations that are not appropriate from an efficiency perspective. To avoid such possibility, the agencies are not premising the proposed standards on use of VSL, and instead will rely on the industry to select VSL when circumstances are appropriate for its use. Implementation of this program may provide greater information for using this technology in standard setting in the future. Many stakeholders including the American Trucking Association have advocated for more widespread use of vehicle speed limits to address fuel efficiency and greenhouse gas emissions. We welcome comments on our decision not to premise the emission standards on the use of VSLs.

Table III–4 provides the proposed application rates of each technology broken down by weight class, cab configuration, and roof height.

Table III-4: Proposed Technology Application Rates for Class 7 and 8 Tractors

	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
Aerodynamics (Cd)							
Classic	0%	0%	0%	0%	0%	10%	0%
Conventional	40%	30%	40%	30%	30%	20%	10%
SmartWay	50%	60%	50%	60%	60%	60%	70%
Advanced SmartWay	10%	10%	10%	10%	10%	10%	20%
Advanced SmartWay II	0%	0%	0%	0%	0%	0%	0%
Steer Tires (Crr kg/metric ton)							
Baseline	40%	30%	40%	30%	30%	30%	10%
SmartWay	50%	60%	50%	60%	60%	60%	70%
Advanced SmartWay	10%	10%	10%	10%	10%	10%	20%
Drive Tires (Crr kg/metric ton)							
Baseline	40%	30%	40%	30%	30%	30%	10%
SmartWay	50%	60%	50%	60%	60%	60%	70%
Advanced SmartWay	10%	10%	10%	10%	10%	10%	20%
Weight Reduction (lb)							
Control	100%	100%	100%	100%	100%	100%	100%
Extended Idle Reduction (gram CO_2/ton-mile reduction)							
Control	N/A	N/A	N/A	N/A	100%	100%	100%
Vehicle Speed Limiter							
Control	0%	0%	0%	0%	0%	0%	0%

(iv) Derivation of the Proposed Tractor Standards

The agencies used the technology inputs and proposed technology application rates in GEM to develop the proposed fuel consumption and CO_2 emissions standards for each subcategory of Class 7 and 8 combination tractors. The agencies derived a scenario truck for each subcategory by weighting the individual GEM input parameters included in Table III–3 by the application rates in Table III–4. For example, the Cd value for a Class 8 Sleeper Cab High Roof scenario case was derived as 10 percent times 0.68 plus 70 percent times 0.60 plus 20 percent times 0.55, which is equal to a Cd of 0.60. Similar calculations were done for tire rolling resistance, weight reduction, idle reduction, and vehicle speed limiters. To account for the two proposed engine standards, the agencies assumed a compliant engine in GEM. In other words, EPA is proposing the use of a 2014 model year fuel consumption map in GEM to derive the 2014 model year tractor standard and a 2017 model year fuel consumption map to derive the 2017 model year tractor standard.[141] The agencies then ran GEM with a single set of vehicle inputs, as shown in Table III–5, to derive the proposed standards for each subcategory. Additional detail is provided in the draft RIA Chapter 2.

[141] As explained further in Section V below, EPA would use these inputs in GEM even for engines electing to use the alternative engine standard.

Table III-5: GEM Inputs for the Class 7 and 8 Tractor Standard Setting

	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
Aerodynamics (Cd)	0.77	0.62	0.77	0.62	0.76	0.72	0.60
Steer Tire CRR (kg/metric ton)	6.99	6.87	6.99	6.87	6.87	6.87	6.54
Drive Tire CRR (kg/metric ton)	7.38	7.26	7.38	7.26	7.26	7.26	6.92
Weight Reduction (lb)	400	400	400	400	400	400	400
Extended Idle Reduction (g/ton-mile)	--	--	--	--	5	5	5
Vehicle Speed Limiter	--	--	--	--	--	--	--
2014 MY Proposed Standard							
Engine	2014 MY 11L	2014 MY 11L	2014 MY 15L	2014 MY 15L	2014 MY 15L	2014 MY 15L	2014 MY 15L
2017 MY Proposed Standard							
Engine	2017 MY 11L	2017 MY 11L	2017 MY 15L	2017 MY 15L	2017 MY 15L	2017 MY 15L	2017 MY 15L

The level of the 2014 and 2017 model year proposed standards and percent reduction from the baseline for each subcategory is included in Table III–6.

Table III-6: Proposed 2014 and 2017 Model Year Tractor Reductions

	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
2014 Model Year							
2014 MY Voluntary Fuel Consumption Standard (gallon/1,000 ton-mile)	10.3	11.6	7.8	8.6	6.3	6.9	7.1
2014 MY CO_2 Standard (grams CO_2/ton-mile)	104	118	79	87	65	70	73
Percent Reduction	6%	9%	6%	9%	15%	14%	18%
2017 Model Year							
2017 MY Fuel Consumption Standard (gallon/1,000 ton-mile)	10.1	11.4	7.7	8.5	6.3	6.8	7.0
2017 MY CO_2 Standard (grams CO_2/ton-mile)	103	116	78	86	64	69	71
Percent Reduction	7%	11%	7%	10%	16%	15%	20%

A summary of the proposed technology package costs is included in Table III–7 with additional details available in the draft RIA Chapter 2.

Table III-7: Class 7 and 8 Tractor Technology Costs inclusive of Indirect Cost Markups in the 2014 Model Year[a] (2008$)

	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
Aerodynamics	$975	$1,216	$647	$1,215	$1,025	$1,151	$1,527
Steer Tires	$65	$65	$65	$65	$65	$65	$65
Drive Tires	$60	$60	$121	$121	$121	$121	$121
Weight Reduction	$1,472	$1,472	$2,421	$2,421	$2,421	$2,421	$2,421
Auxiliary Power Unit	N/A	N/A	N/A	N/A	$3,660	$3,660	$3,660
Air Conditioning	$21	$21	$21	$21	$21	$21	$21
Total	$2,593	$2,835	$3,275	$3,842	$7,312	$7,438	$7,814

Notes:

[a] Costs shown are for the 2014 model year so do not reflect learning impacts which would result in lower costs for later model years. For a description of the learning impacts considered in this analysis and how it impacts technology costs for other years, refer to Chapter 2 of the draft RIA.

[b] Note that values in this table include penetration rates. Therefore, the technology costs shown reflect the average cost expected for each of the indicated classes. To see the actual estimated technology costs exclusive of penetration rates, refer to Chapter 2 of the draft RIA.

(v) Reasonableness of the Proposed Standards

The proposed standards are based on aggressive application rates for control technologies which the agencies regard as the maximum feasible for the reasons given in Section (iii) above; *see also* draft RIA Chapter 2.5.8.2. These technologies, at the estimated application rates, are available within the lead time provided, as discussed in draft RIA Chapter 2.5. Use of these technologies would add only a small amount to the cost of the vehicle, and the associated reductions are highly cost effective, an estimated $10 per ton of CO_2eq per vehicle in 2030 without consideration of the substantial fuel savings.[142] This is even more cost effective than the estimated cost effectiveness for CO_2eq removal and fuel economy improvements under the light-duty vehicle rule, already considered by the agencies to be a highly cost effective reduction.[143] Moreover, the cost of controls is recovered due to the associated fuel savings, as shown in the payback analysis included in Table VIII–8 located in Section VIII below. Thus, overall cost per ton of the rule, considering fuel savings, is negative—fuel savings associated with the rule more than offset projected costs by a wide margin. *See* Table VIII–5 in Section VIII below. Given that the standards are technically feasible within the lead time afforded by the 2014 model year, are inexpensive and highly cost effective even without 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 represent a reasonable choice under section 202(a) of the CAA and under NHTSA's EISA authority at 49 U.S.C. 32902(k)(2).

(vi) Alternative Tractor Standards Considered

The agencies are not proposing tractor standards less stringent than the proposed standards because the agencies believe these standards are appropriate, highly cost effective, and technologically feasible within the rulemaking time frame. We welcome comments supplemented with data on each aspect of this determination most importantly on individual technology efficacy to reduce fuel consumption and GHGs as well was our estimates of individual technology cost and lead-time.

The agencies considered proposing tractor standards which are more stringent than those proposed reflecting increased application rates of the technologies discussed. We also considered setting more stringent standards based on the inclusion of hybrid powertrains in tractors. We stopped short of proposing more stringent standards based on higher application rates of improved aerodynamic controls and tire rolling resistance because we concluded that the technologies would not be compatible with the use profile of a subset of tractors which operate in offroad conditions. The agencies welcome comment on the application rates for each type of technology and for each tractor category. We have not proposed more stringent standards for tractors based on the use of hybrid vehicle technologies, believing that additional development and therefore lead-time is needed to develop hybrid systems and battery technology for tractors that operate primarily in highway cruise operations. We know,

[142] *See* Section VIII.D below.

[143] The light-duty rule had an estimated cost per ton of $50 when considering the vehicle program costs only and a cost of −$210 per ton considering the vehicle program costs along with fuel savings in 2030. *See* 75 FR 25515, Table III.H.3–1.

for example, that hybrid systems are being researched to capture and return energy for tractors that operate in gently rolling hills. However, it is not clear to us today that these systems will be generally applicable to tractors in the timeframe of this regulation. We seek comment on our assessment on the appropriateness of setting standards based on the use of hybrid technologies. Further, the agencies request comment supported by data regarding additional technologies not considered by the agencies in proposing these standards.

(b) Tractor Engines

(i) Baseline Engine Performance

As noted above, EPA and NHTSA developed the baseline medium and heavy heavy-duty diesel engine to represent a 2010 model year engine compliant with the 0.2 g/bhp-hr NO_X standard for on-highway heavy-duty engines.

The agencies developed baseline SET values for medium and heavy heavy-duty diesel engines based on 2009 model year confidential manufacturer data and from testing conducted by EPA. The agencies adjusted the pre-2010 data to represent 2010 model year engine maps by using predefined technologies including SCR and other systems that are being used in current 2010 model year production. If an engine utilized did not meet the 0.2 g/bhp-hr NO_X level, then the individual engine's CO_2 result was adjusted to accommodate aftertreatment strategies that would result in a 0.2 g/bhp-hr NO_X emission level as described in draft RIA Chapter 2.4.2.1. The engine CO_2 results were then sales weighted within each regulatory subcategory to develop an industry average 2010 model year reference engine. While most of the engines fell within a few percent of this baseline at least one engine was more than six percent above this average baseline.

Table III-8: 2010 Model Year Baseline Diesel Engine Performance

	CO_2 Emissions (g/bhp-hr)	Fuel Consumption (gallon/100 bhp-hr)
Medium Heavy Diesel - SET	518	5.09
Heavy Heavy Diesel - SET	490	4.81

(ii) Engine Technology Package Effectiveness

The MHD and HHD diesel engine technology package for the 2014 model year includes engine friction reduction, improved aftertreatment effectiveness, improved combustion processes, and low temperature EGR system optimization. The agencies considered improvements in parasitic and friction losses through piston designs to reduce friction, improved lubrication, and improved water pump and oil pump designs to reduce parasitic losses. The aftertreatment improvements are available through lower backpressure of the systems and optimization of the engine-out NO_X levels. Improvements to the EGR system and air flow through the intake and exhaust systems, along with turbochargers can also produce engine efficiency improvements. We note that individual technology improvements are not additive due to the interaction of technologies. The agencies assessed the impact of each technology over each of the 13 SET modes to project an overall weighted SET cycle improvement in the 2014 model year of 3 percent, as detailed in draft RIA Chapter 2.4.2.9 through 2.4.2.14. All of these technologies represent engine enhancements already developed beyond the research phase and are available as "off the shelf" technologies for manufacturers to add to their engines during the engine's next design cycle. We have estimated that manufacturers will be able to implement these technologies on or before the 2014 engine model year. The agencies proposal therefore reflects a 100 percent application rate of this technology package. The agencies gave consideration to proposing a more stringent standard based on the application of turbocompounding, a mechanical means of waste heat recovery, but concluded that manufacturers would have insufficient lead-time to complete the necessary product development and validation work necessary to include this technology across the industry by model year 2014.

As explained earlier, EPA's heavy-duty highway engine standards for criteria pollutants apply in three year increments. The heavy-duty engine manufacturer product plans have fallen into three year cycles to reflect these requirements. The agencies are proposing to set fuel consumption and CO_2 emission standards recognizing the opportunity for technology improvements over this timeframe while reflecting the typical heavy-duty engine manufacturer product plan redesign and refresh cycles. Thus, the agencies are proposing to set a more stringent standard for heavy-duty engines beginning in the 2017 model year.

The MHDD and HHDD engine technology package for the 2017 model year includes the continued development of the 2014 model year technology package including refinement of the aftertreatment system plus turbocompounding. The agencies calculated overall reductions in the same manner as for the 2014 model year package. The weighted SET cycle improvements lead to a 6 percent reduction on the SET cycle, as detailed in draft RIA Chapter 2.4.2.12. The agencies' proposal is premised on a 100 percent application rate of this technology package. We gave consideration to proposing an even more stringent standard based on the use of advanced Rankine cycle (also called bottoming cycle) engine technology but concluded that there is insufficient lead-time between now and 2017 for this promising technology to be developed and applied generally to all heavy-duty engines.[144] Therefore, these technologies were not included in determining the stringency of the proposed standards. However, we do believe the bottoming cycle approach represents a significant opportunity to reduce fuel consumption and GHG emissions in the future. EPA and NHTSA are therefore both proposing provisions described in Section IV to create incentives for manufacturers to

[144] TIAX noted in their report to the NAS committee that the engine improvements beyond 2015 model year included in their report are highly uncertain, though they include Rankine cycle type waste heat recovery as applicable sometime between 2016 and 2020 (page 4–29).

continue to invest to develop this technology.

(iii) Derivation of Engine Standards

EPA developed the proposed 2014 model year CO_2 emissions standards (based on the SET cycle) for diesel engines by applying the three percent reduction from the technology package (just explained above) to the 2010 model year baseline values determined using the SET cycle. EPA developed the 2017 model year CO_2 emissions standards for diesel engines while NHTSA similarly developed the 2017 model year diesel engine fuel consumption standards by applying the 6 percent reduction from the 2017 model year technology package (reflecting performance of turbocompounding plus the 2014 MY technology package) to the 2010 model year baseline values. The proposed standards are included in Table III–9.

Table III-9: Proposed Diesel Engine Standards Over the SET Cycle

Model Year		MHD Diesel Engine	HHD Diesel Engine
2014 – 2016	CO_2 Standard (g/bhp-hr)	502	475
	Voluntary Fuel Consumption Standard (gallon/100 bhp-hr)	4.93	4.67
2017 and later	CO_2 Standard (g/bhp-hr)	487	460
	Fuel Consumption (gallon/100 bhp-hr)	4.78	4.52

(iv) Engine Technology Package Costs

EPA has historically used two different approaches to estimate the indirect costs (sometimes called fixed costs) of regulations including costs for product development, machine tooling, new capital investments and other general forms of overhead that do not change with incremental changes in manufacturing volumes. Where the Agency could reasonably make a specific estimate of individual components of these indirect costs, EPA has done so. Where EPA could not readily make such an estimate, EPA has instead relied on the use of markup factors referred to as indirect cost multipliers (ICMs) to estimate these indirect costs as a ratio of direct manufacturing costs. In general, EPA has used whichever approach it believed could provide the most accurate assessment of cost on a case by case basis. The agencies' general approach used elsewhere in this proposal (for HD pickup trucks, gasoline engines, combination tractors, and vocational vehicles) estimates indirect costs based on the use of ICMs. *See also* 75 FR 25376. We have used this approach generally because these standards are based on 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. In this situation, we believe that the ICM approach provides an accurate and clear estimate of the additional indirect costs borne by the manufacturer.

For the heavy-duty diesel engine segment, however, the agencies do not consider this model to be the most appropriate because the primary cost is not expected to be 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. Most of the technologies the agencies are projecting the heavy-duty engine manufacturers will use for compliance reflect modifications to existing engine systems rather than wholesale addition of technology (*e.g.,* improved turbochargers rather than adding a turbocharger where it did not exist before as was done in our light-duty joint rulemaking in the case of turbo-downsizing). When the bulk of the costs come from refining an existing technology rather than a wholesale addition of technology, a specific estimate of indirect costs may be more appropriate. For example, combustion optimization may significantly reduce emissions and cost a manufacturer millions of dollars to develop but will 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.

The agencies developed the engineering costs for the research and development of diesel engines with lower fuel consumption and CO_2 emissions. The aggregate costs for engineering hours, technician support, dynamometer cell time, and fabrication of prototype parts are estimated at $6,750,000 per manufacturer per year over the five years covering 2012 through 2016. In aggregate, this averages out to $280 per engine during 2012 through 2016 using an annual sales value of 600,000 light-, medium- and heavy-HD engines. The agencies also are estimating costs of $100,000 per engine manufacturer per engine class (light-, medium- and heavy-HD) to cover the cost of purchasing photo-acoustic measurement equipment for two engine test cells. This would be a one-time cost incurred in the year prior to implementation of the standard (*i.e.,* the cost would be incurred in 2013). In aggregate, this averages out to $4 per engine in 2013 using an annual sales value of 600,000 light-, medium- and heavy-HD engines.

Where we projected that additional new hardware was needed to the meet the proposed standards, we developed the incremental costs for those technologies and marked them up using the ICM approach. Table III–10 below summarizes those estimates of cost on a per item basis. All costs shown in Table III–18 include a low complexity ICM of 1.11 and time based learning is considered applicable to each technology.

Table III-10: Heavy-duty Diesel Engine Component Costs for Combination Tractors (2008$)

	2014 Model Year	2017 Model Year
Cylinder Head (flow optimized, increased firing pressure, improved thermal management)	$6	$6
Exhaust Manifold (flow optimized, improved thermal management)	$0	$0
Turbocharger (improved efficiency)	$17	$16
EGR Cooler (improved efficiency)	$3	$3
Water Pump (optimized, variable vane, variable speed)	$87	$79
Oil Pump (optimized)	$4	$4
Fuel Pump (higher working pressure, increased efficiency, improved pressure regulation)	$4	$4
Fuel Rail (higher working pressure)	$10	$9
Fuel Injector (optimized, improved multiple event control, higher working pressure)	$10	$9
Piston (reduced friction skirt, ring and pin)	$3	$2
Aftertreatment system (improved effectiveness SCR, dosing, dpf)[a]	$0	$0
Valve Train (reduced friction, roller tappet, MHD only)	$78	$71
Mechanical Turbocompounding	$0	$823

Note:
[a] Costs for aftertreatment improvements for MH and HH diesel engines are covered via the engineering costs (see text). For LH diesel engines, we have included the cost of aftertreatment improvements as a technology cost.

The overall diesel engine technology package cost for a medium HD engine being placed in a combination tractor is $223 in the 2014 model year and $1,027 in the 2017 model year; for a heavy HD engine being placed in a combination tractor these costs are $145 and $955 in the 2014 and 2017 model years, respectively. The differences for the medium HD engines are the valve train friction reduction costs of $78 in 2014 ($71 in 2017) that are not applied to heavy HD engines.

(v) Reasonableness of the Proposed Standards

The proposed engine standards appear to be reasonable and consistent with the agencies' respective statutory authorities. With respect to the 2014 and 2017 MY standards, all of the technologies on which the standards are predicated have already been demonstrated in some capacity and their effectiveness is well documented. The proposal reflects a 100 percent application rate for these technologies. The costs of adding these technologies remain modest across the various engine classes as shown in Table III–10. Use of these technologies would add only a small amount to the cost of the vehicle,[145] and the associated reductions are highly cost effective, an estimated $6 per ton of CO_2eq per vehicle.[146] This is even more cost effective than the estimated cost effectiveness for CO_2eq removal under the light-duty vehicle rule, already considered by the agencies to be a highly cost effective reduction.[147] Even the more expensive 2017 MY proposed standard still represents only a small fraction of the vehicle's total cost and is even more cost effective than the light-duty vehicle rule. Moreover, costs are more than offset by fuel savings. Accordingly, EPA and NHTSA view these standards as reflecting an appropriate balance of the various statutory factors under section 202(a) of the CAA and under NHTSA's EISA authority at 49 U.S.C. 32902(k)(2).

(vi) Temporary Alternative Standard for Certain Engine Families

As discussed above in Section II.B (1)(b), notwithstanding the general reasonableness of the proposed standards, the agencies recognize that heavy-duty engines have never been subject to GHG or fuel consumption (or fuel economy) standards and that such control has not necessarily been an independent priority for manufacturers. The result is that there are a group of legacy engines with emissions higher than the industry baseline for which compliance with the proposed 2014 MY standards may be more challenging and for which there may simply be inadequate lead time. The issue is not whether these engines' GHG and fuel consumption performance cannot be improved by utilizing the technology packages on which the proposed standards are based. Those technologies can be utilized by all engines and the same degree of reductions obtained. Rather the underlying base engine components of these engines reflect designs that are decades old and therefore have base performance levels below what is typical for the industry as a whole today. Manufacturers have been gradually replacing these legacy products with new engines. Engine

[145] Sample 2010 MY day cabs are priced at $89,000 while 2010 MY sleeper cabs are priced at $113,000. See page 3 of ICF's "Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for Heavy-Duty On-Road Vehicles." July 2010.

[146] See Tractor CO_2 savings and technology costs for Alternative 2 in Section IX.B.

[147] The light-duty rule had an estimated cost per ton of $50 when considering the vehicle program costs only and a cost of -$210 per ton considering the vehicle program costs along with fuel savings in 2030. *See* 75 FR 25515, Table III.H.3–1.

manufacturers have indicated to the agencies they will have to align their planned replacement of these products with our proposed standards and at the same time add additional technologies beyond those identified by the agencies as the basis for the proposed standard. Because these changes will reflect a larger degree of overall engine redesign, manufacturers may not be able to complete this work for all of their legacy products prior to model year 2014. To pull ahead these already planned engine replacements would be impossible as a practical matter given the engineering structure and lead-times inherent in the companies' existing product development processes. We have also concluded that the use of fleet averaging would not address the issue of legacy engines because each manufacturer typically produces only a limited line of MHDD and HHDD engines. (Because there are ample fleetwide averaging opportunities for heavy-duty pickups and vans, the agencies do not perceive similar difficulties for these vehicles.)

Facing a similar issue in the light-duty vehicle rule, EPA adopted a Temporary Lead Time Allowance provision whereby a limited number of vehicles of a subset of manufacturers would meet an alternative standard in the early years of the program, affording them sufficient lead time to meet the more stringent standards applicable in later model years. See 75 FR 25414–25418. The agencies are proposing a similar approach here. As explained above in Section II B. (1) (b), the agencies are proposing a regulatory alternative whereby a manufacturer, for a limited period, would have the option to comply with a unique standard requiring the same level of reduction of emissions (i.e., percent removal) and fuel consumption as otherwise required, but the reduction would be measured from its own 2011 model year baseline. We are thus proposing an optional standard whereby manufacturers would elect to have designated engine families meet a standard of 3% reduction from their 2011 baseline emission and fuel consumption levels for that engine family. Our assessment is that this three percent reduction is appropriate based on use of similar technology packages at similar cost as we have estimated for the primary program. As explained earlier, we are not proposing that the option to select an alternative standard continues past the 2016 MY. By this time, the engines should have gone through a redesign cycle which will allow manufacturers to replace those legacy engines which resulted in abnormally high baseline emission and fuel consumption levels and to achieve the MY 2017 standards which would be feasible using the technology package set out above (optimized NOX aftertreatment, improved EGR, reductions in parasitic losses, and turbocharging). Manufacturers would, of course, be free to adopt other technology paths which meet the proposed MY 2017 standards.

Since the alternative standard is premised on the need for additional lead time, manufacturers would first have to utilize all available flexibilities which could otherwise provide that lead time. Thus, the alternative would not be available unless and until a manufacturer had exhausted all available credits and credit opportunities, and engines under the alternative standard could not generate credits. *See* 75 FR 25417–25419 (similar approach for vehicles which are part of Temporary Lead Time Allowance under the light-duty vehicle rule). We are proposing that manufacturers can select engine families for this alternative standard without agency approval, but are proposing to require that manufacturers notify the agency of their choice and to include in that notification a demonstration that it has exhausted all available credits and credit opportunities. Manufacturers would also have to demonstrate their 2011 baseline calculations as part of the certification process for each engine family for which the manufacturer elects to use the alternative standard. *See* Section V.C.1(b)(i) below.

(vii) Alternative Engine Standards Considered

The agencies are not proposing engine standards less stringent than the proposed standards because the agencies believe these proposed standards are appropriate, highly cost effective, and technologically feasible, as just described. We welcome comments supplemented with data on each aspect of this determination most importantly on individual engine technology efficacy to reduce fuel consumption and GHG emissions. Comments should also address our estimates of individual technology cost and lead-time.

The agencies considered proposing engine standards which are more stringent. Since the proposed standards reflect 100 percent utilization of the various technology packages, some additional technology would have to be added. The agencies are proposing 2017 model year standards based on the use of turbocompounding. The agencies considered the inclusion of more advanced heat recovery systems, such as Rankine or bottoming cycles, which would provide further reductions. However, the agencies are not proposing this level of stringency because our assessment is that these technologies would not be available for production by the 2017 model year. The agencies welcome comments on whether waste heat recovery technologies are appropriate to consider for the 2017 model year standard, or if not, then when would they be appropriate.

B. Heavy-Duty Pickup Trucks and Vans

This section describes the process the agencies used to develop the standards the agencies are proposing for HD pickups and vans. We started by gathering available information about the fuel consumption and CO_2 emissions from recent model year vehicles. The core portion of this information comes primarily from EPA's certification databases, CFEIS and VERIFY, which contain the publicly available data [148] regarding emission and fuel economy results. This information is not extensive because manufacturers have not been required to chassis test HD diesel vehicles for EPA's criteria pollutant emissions standards, nor have they been required to conduct any testing of heavy-duty vehicles on the highway cycle. Nevertheless, enough certification activity has occurred for diesels under EPA's optional chassis-based program, and, due to a California NO_X requirement for the highway test cycle, enough test results have been voluntarily reported for both diesel and gasoline vehicles using the highway test cycle, to yield a reasonably robust data set. To supplement this data set, for purposes of this rulemaking EPA initiated its own testing program using in-use vehicles. This program and the results from it thus far are described in a memorandum to the docket for this rulemaking.[149]

Heavy-duty pickup trucks and vans are sold in a variety of configurations to meet market demands. Among the differences in these configurations that affect CO_2 emissions and fuel consumption are curb weight, GVWR, axle ratio, and drive wheels (two-wheel drive or four-wheel drive). Because the currently-available test data set does not capture all of these configurations, it is necessary to extend that data set across the product mix using adjustment factors. In this way a test result from, say a truck with two-wheel drive, 3.73:1 axle ratio, and 8000 lb test weight, can

[148] *http://www.epa.gov/otaq/certdata.htm.*

[149] Memorandum from Cleophas Jackson, U.S. EPA, to docket EPA–HQ–OAR–2010–0162, "Heavy-Duty Greenhouse Gas and Fuel Consumption Test Program Summary", September 20, 2010.

be used to model emissions and fuel consumption from a truck of the same basic body design, but with 4wd, a 4.10:1 axle ratio, and 8,500 lb test weight. The adjustment factors are based on data from testing in which only the parameters of interest are varied. These parameterized adjustments and their basis are also described in a memorandum to the docket for this rulemaking.[150]

The agencies requested and received from each of the three major manufacturers confidential information for each model and configuration, indicating the values of each of these key parameters as well as the annual production (for the U.S. market). Production figures are useful because, under our proposed standards for HD pickups and vans, compliance is judged on the basis of production-weighted (corporate average) emissions or fuel consumption level, not individual vehicle levels. For consistency and to avoid confounding the analysis with data from unusual market conditions in 2009, the production and vehicle specification data is from the 2008 model year. We made the simplifying assumption that these sales figures reasonably approximate future sales for purposes of this analysis.

One additional assessment was needed to make the data set useful as a baseline for the standards selection. Because the appropriate standards are determined by applying efficiency-improving technologies to the baseline fleet, it is necessary to know the level of penetration of these technologies in the latest model year (2010). This information was also provided confidentially by the manufacturers. Generally, the agencies found that the HD pickup and van fleet was at a roughly consistent level of technology application, with (1) the transition from 4-speed to 5- or 6-speed automatic transmissions mostly accomplished, (2) coupled cam phasing to achieve variable valve control on gasoline engines likewise mostly in place, and (3) substantial remaining potential for optimizing catalytic diesel NO_X aftertreatment to improve fuel economy (the new heavy-duty NO_X standards having taken effect in the 2010 model year).

Taking this 2010 baseline fleet, and applying the technologies determined to be feasible and appropriate by the 2018 model year, along with their effectiveness levels, the agencies could then make a determination of appropriate proposed standards. The assessment of feasibility, described immediately below, takes into account the projected costs of these technologies. The derivation of these costs, largely based on analyses developed in the light-duty GHG and fuel economy rulemaking, are described in Section III.B(3).

Our assessment concluded that the technologies that the agencies considered feasible and appropriate for HD pickups and vans could be consistently applied to essentially all vehicles across this sector by the 2018 model year. Therefore we did not apply varying penetration rates across vehicle types and models in developing and evaluating the proposed standards.

Since the manufacturers of HD pickups and vans generally only have one basic pick-up truck and van with different versions ((*i.e.,* different wheel bases, cab sizes, two-wheel drive, four-wheel drive, *etc.*) and do not have the flexibility of the light-duty fleet to coordinate model improvements over several years, changes to the HD pickups and vans to meet new standards must be carefully planned with the redesign cycle taken into account. 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 8 or more years. However, opportunities for gradual improvements not necessarily linked to large scale changes can occur between the redesign cycles. Examples of such improvements are upgrades to an existing vehicle model's engine, transmission and aftertreatment systems. Given this long redesign cycle and our 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 2018 model year.

Although we did not determine that it was necessary for feasibility to apply varying technology penetration levels to different vehicles, we did decide that a phased implementation schedule would be appropriate to accommodate manufacturers' redesign workload and product schedules, especially in light of this sector's relatively low sales volumes and long product cycles. We did not determine a specific cost of implementing the final standards immediately in 2014 without a phase-in, but we assessed it to be much higher than the cost of the phase-in we are proposing, due to the workload and product cycle disruptions it would 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* generally 75 FR 25467–25468 explaining why attempting major changes outside the redesign cycle period raises very significant issues of both feasibility and cost. On the other hand, waiting until 2018 before applying any new standards could miss the opportunity to achieve meaningful and cost-effective early reductions not requiring a major product redesign when the largest changes and reductions are expected to occur.

The proposed phase-in schedule, 15–20–40–60–100 percent in 2014–2015–2016–2017–2018, respectively, was chosen to strike a balance between meaningful reductions in the early years (reflecting the technologies' penetration rates of 15 and 20 percent) and providing manufacturers with needed lead time via a gradually accelerating ramp-up of technology penetration.[151] By expressing the proposed phase-in in terms of increasing fleetwide stringency for each manufacturer, while also providing for credit generation and use (including averaging, carry-forward, and carry-back), we believe our proposal affords manufacturers substantial flexibility to satisfy the phase-in through a variety of pathways: the gradual application of technologies across the fleet (averaging a fifth of total production in each year), greater application levels on only a portion of the fleet, or a mix of the two.

We considered setting more stringent standards that would require the application of additional technologies by 2018. 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. This dynamic has played out in EPA programs before and highlights the value of setting performance-based standards that leave engineers the freedom to find the most cost-effective solutions.

However, the agencies do believe that at this stage there is not enough information to conclude that the additional technologies provide an appropriate basis for standard-setting. For example, we believe that 42V stop-start systems can be applied to gasoline vehicles with significant GHG and fuel

[150] Memorandum from Anthony Neam and Jeff Cherry, U.S. EPA, to docket EPA–HQ–OAR–2010–0162, October 18, 2010.

[151] The NHTSA proposal provides voluntary standards for model years 2014 and 2015. NHTSA and EPA also propose to provide an alternative standards phase-in that meets EISA's requirement for three years of regulatory stability. *See* Section II.C.d.ii for a more detailed discussion.

consumption benefits, but we recognize that there is uncertainty at this time over the cost-effectiveness of these systems in heavy-duty applications, and over customer acceptance of vehicles with high GCWR towing large loads that would routinely stop running at idle. Hybrid electric technology likewise could be applied to heavy-duty vehicles, and in fact has already been so applied on a limited basis. However, the development, design, and tooling effort needed to apply this technology to a vehicle model is quite large, and seems less likely to prove cost-effective in this timeframe, due to the small sales volumes relative to the light-duty sector. Here again, potential customer acceptance would need to be better understood because the smaller engines that facilitate much of a hybrid's benefit are typically at odds with the importance pickup trucks buyers place on engine horsepower and torque, whatever the vehicle's real performance.

We also considered setting less stringent standards calling for a more limited set of applied technologies. However, our assessment concluded with a high degree of confidence that the technologies on which the proposed standards are premised are clearly available at reasonable cost in the 2014–2018 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 effectiveness of the technologies whose performance is the basis of the proposed standards. Our basis for these estimates is described in Section III.B.(1)(1) . Because for the most part these technologies have not yet been applied to HD pickups and vans, even on a limited basis, we are 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 our recent rulemaking on light-duty vehicle GHGs and fuel economy, and have generated a robust set of effectiveness values.

We solicit comment and new information that would aid the agencies in establishing the appropriate level of stringency for the HD pickup and van standards, and on all facets of the assessment described here and elsewhere in these rulemaking proposals.

(1) 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 2014–2018. The majority of the technologies described in this section is readily available, well known, 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 which 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 proposal.

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 ratio between gasoline and diesel engine purchases by consumers has tended to track changes in the overall cost of oil and the relative cost of gasoline and diesel fuels. When oil prices are higher, diesel sales tend to increase. This trend has reversed when oil prices fall or when diesel fuel prices are significantly higher than gasoline. 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 does not force, nor does it discourage, changes in a manufacturer's fleet mix between gasoline and diesel vehicles. Although we considered setting a single standard based on the performance level possible for diesel vehicles, we are not proposing such an approach because the potential disruption in the HD pickup and van market from a forced shift would not be justified. 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.
- *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.
- *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.
- *Diesel engine improvements and diesel aftertreatment improvements*—improved 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:

- *Improved automatic transmission controls*—optimizes shift schedule to maximize fuel efficiency under wide ranging conditions, and minimizes losses associated with torque converter slip through lock-up or modulation.

• *Six-, seven-, and eight-speed automatic transmissions*—the gear ratio spacing and transmission ratio are optimized for a broader range of engine operating conditions.

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 proposal.

Types of electrification/accessory and hybrid technologies considered include:

• *Electric power steering and Electro-Hydraulic 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.

• *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.[152]

How did the agencies determine the costs and effectiveness of each of these technologies?

Building on the technical analysis underlying the 2012–2016 MY light-duty vehicle rule, 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 NHTSA and EPA in the light-duty rule.

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.[153]

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 2008 dollars using a ratio of gross domestic product (GDP) values for the associated calendar years,[154] and indirect costs were accounted for using the new approach developed by EPA and used in the 2012–2016 light-duty rule. 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, although some of these adjustments may be different for each agency due to the different vehicle subclasses used in their respective models.

Regarding estimates for technology effectiveness, NHTSA and EPA used the estimates from the 2012–2016 light-duty rule as a baseline but adjusted them 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 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. NHTSA and EPA engineers 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 NPRM, 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

[152] See draft RIA Chapter 2.3 for fuller technology descriptions.

[153] 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.

[154] NHTSA examined the use of the CPI multiplier instead of GDP for adjusting these dollar values, but found the difference to be exceedingly small—only $0.14 over $100.

(and individual vehicles) might obtain from adding a fuel-saving technology. However, the agencies seek comment on whether additional levels of specificity beyond that already provided would improve the analysis for the final rules, and if so, how those levels of specificity should be analyzed.

The following section contains a detailed description of our assessment of vehicle technology cost and effectiveness estimates. The agencies note that the technology costs included in this NPRM take into account only those associated with the initial build of the vehicle. The agencies seek comment on the additional lifetime costs, if any, associated with the implementation of advanced technologies including maintenance and replacement costs. Based on comments, the agencies may decide to conduct additional analysis for the final rules regarding operating, maintenance and replacement costs.

(a) Engine Technologies

NHTSA and EPA have reviewed the engine technology estimates used in the 2012–2016 light-duty rule. In doing so NHTSA and EPA reconsidered all available sources and updated the estimates as appropriate. The section below describes both diesel and gasoline engine technologies considered for this proposal.

(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.

Based on the 2012–2016 MY light-duty vehicle rule, and previously-received confidential manufacturer data, NHTSA and EPA estimated the effectiveness of low friction lubricants to be between 0 to 1 percent.

In the light-duty rule, the agencies estimated the cost of moving to low friction lubricants at $3 per vehicle (2007$). That estimate included a markup of 1.11 for a low complexity technology. For HD pickups and vans, we are using the same base estimate but have marked it up to 2008 dollars using the GDP price deflator and have used a markup of 1.17 for a low complexity technology to arrive at a value of $4 per vehicle. As in the light-duty rule, learning effects are not applied to costs for this technology and, as such, this estimate applies to all model years.[155] [156]

(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.[157] 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. The 2012–2016 light-duty final rule, the 2010 NAS Report, and NESCCAF and Energy and Environmental Analysis reports, as well as confidential manufacturer data, indicate a range of effectiveness for engine friction reduction to be between 1 to 3 percent. NHTSA and EPA continue to believe that this range is accurate.

Consistent with the 2012–2016 MY light-duty vehicle rule, the agencies estimate the cost of this technology at $14 per cylinder compliance cost (2008$), including the low complexity ICM markup value of 1.17. Learning impacts are not applied to the costs of this technology and, as such, this estimate applies to all model years. This cost is multiplied by the number of engine cylinders.

(iii) 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.[158] 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.[159]

Based on the 2012–2016 light-duty final rule, previously-received confidential manufacturer data, and the NESCCAF report, NHTSA and EPA estimated the effectiveness of couple cam phasing to be between 1 and 4 percent. NHTSA and EPA reviewed this estimate for purposes of the NPRM, and continue to find it accurate.

In the 2012–2016 light-duty final rule, the agencies estimated a $41 cost per cam phaser not including any markup (2007$). NHTSA and EPA believe that this estimate remains accurate. Using the new indirect cost multiplier of 1.17, for a low complexity technology, the compliance cost per cam phaser would be $46 (2008$) in the 2014 model year. Time-based learning is applied to this

[155] Note that throughout the cost estimates for this HD analysis, the agencies have used slightly higher markups than those used in the 2012–2016 MY light-duty vehicle rule. The new, slightly higher ICMs include return on capital of roughly 6%, a factor that was not included in the light-duty analysis.

[156] Note that the costs developed for low friction lubes for this analysis reflect the costs associated with any engine changes that would be required as well as any durability testing that may be required.

[157] "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).

[158] 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.

[159] 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.

technology. This technology was considered for gasoline engines only.

(iv) 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 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 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 is a technology keyed to more lightly loaded operation, and so may be a less likely technology choice for manufacturers designing for effectiveness in the loaded condition required for testing, and in the real world that involves frequent operation with heavy loads.

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.

Effectiveness improvements scale roughly with engine displacement-to-vehicle weight ratio: the higher displacement-to-weight vehicles, operating at lower relative loads for normal driving, have the potential to operate in part-cylinder mode more frequently.

NHTSA and EPA adjusted the 2012–2016 light-duty final rule estimates using updated power to weight ratings of heavy-duty trucks and confidential business information and confirmed a range of 3 to 4 percent for these vehicles, though as mentioned above there is uncertainty over how often this technology would be exercised on the test cycles, and a lower range may be warranted for HD vehicles.

NHTSA and EPA consider the costs for this technology to be identical to that for V8 engines on light-duty trucks. As such, the agencies have used the cost used in the 2012–2016 light-duty final rule. Using the new markup of 1.17 for a low complexity technology results in an estimate of $193 (2008$) in the 2014 model year. Time based learning is applied to this technology. This technology was considered for gasoline engines only.

(v) 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.

The 2012–2016 light-duty final rule estimated the range of 1 to 2 percent for SGDI. NHTSA and EPA reviewed this estimate for purposes of the NPRM, and continue to find it accurate.

Consistent with the 2012–2016 light-duty final rule, NHTSA and EPA cost estimates for SGDI take into account the changes required to the engine hardware, engine electronic controls, ancillary and NVH mitigation systems. Through contacts with industry NVH suppliers, and manufacturer press releases, the agencies believe that the NVH treatments will be limited to the mitigation of fuel system noise, specifically from the injectors and the fuel lines. For this analysis, the agencies have estimated the costs at $395 (2008$) in the 2014 model year. Time based learning is applied to this technology. This technology was considered for gasoline engines only, as diesel engines already employ direct injection.

(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.[160] 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 will be improved during the 2014–2018 timeframe. 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 will result in a significant reduction in the amount of fuel used in the process. This technology was not considered in the 2012–2016 light-duty final rule. Based on confidential business information, EPA and NHTSA estimate the reduction in CO_2 as a result of these improvements at 3 to 5 percent.

The agencies have estimated the cost of this technology at $25 for each percentage improvement in fuel consumption. This estimate is based on

[160] 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.

the agencies' belief that this technology is, in fact, a very cost effective approach to improving fuel consumption. As such, $25 per percent improvement is considered a reasonable cost. This cost would cover the engineering and test cell related costs necessary to develop and implement the improved control strategies that would allow for the improvements in fuel consumption. Importantly, the engineering work involved would be expected to result in cost savings to the aftertreatment and control hardware (lower platinum group metal loadings, lower reductant dosing rates, *etc.*). Those savings are considered to be included in the $25 per percent estimate described here. Given the 4 percent average expected improvement in fuel consumption results in an estimated cost of $110 (2008$) for a 2014 model year truck or van. This estimate includes a low complexity ICM of 1.17 and time based learning from 2012 forward.

(ii) Engine Improvements

Diesel engines in the HD pickup and van segment are expected to have several improvements in their base design in the 2014–2018 timeframe. These improvements include items such as improved combustion management, optimal turbocharger design, and improved thermal management. This technology was not considered in the 2012–2016 light-duty final rule. Based on confidential business information, EPA and NHTSA estimate the reduction in CO_2 as a result of these improvements at 4 to 6 percent.

The cost for this technology includes costs associated with low temperature exhaust gas recirculation, improved turbochargers and improvements to other systems and components. These costs are considered collectively in our costing analysis and termed "diesel engine improvements." The agencies have estimated the cost of diesel engine improvements at $147 based on the cost estimates for several individual technologies. Specifically, the direct manufacturing costs we have estimated are: improved cylinder head, $9; turbo efficiency improvements, $16; EGR cooler improvements, $3; higher pressure fuel rail, $10; improved fuel injectors, $13; improved pistons, $2; and reduced valve train friction, $94. All values are in 2008 dollars and are applicable in the 2014MY. Applying a low complexity ICM of 1.17 results in a cost of $172 (2008$) applicable in the 2014MY. We consider time based learning to be appropriate for these technologies.

(c) Transmission Technologies

NHTSA and EPA have also reviewed the transmission technology estimates used in the 2012–2016 light-duty final rule. In doing so, NHTSA and EPA considered or reconsidered all available sources and updated the estimates as appropriate. The section below describes each of the transmission technologies considered for this proposal.

(i) Improved Automatic Transmission Control (Aggressive Shift Logic and Early Torque Converter Lockup)

Calibrating the transmission shift schedule to upshift earlier and quicker, and to lock-up or partially lock-up the torque converter under a broader range of operating conditions can reduce fuel consumption and CO_2 emissions. However, this operation can result in a perceptible degradation in NVH. The degree to which NVH can be degraded before it becomes noticeable to the driver is strongly influenced by characteristics of the vehicle, and although it is somewhat subjective, it always places a limit on how much fuel consumption can be improved by transmission control changes. Given that the Aggressive Shift Logic and Early Torque Converter Lockup are best optimized simultaneously due to the fact that adding both of them primarily requires only minor modifications to the transmission or calibration software, these two technologies are combined in the modeling. We consider these technologies to be present in the baseline, since 6-speed automatic transmissions are installed in the majority of Class 2b and 3 trucks in the 2010 model year timeframe.

(ii) Automatic 6- and 8-Speed Transmissions

Manufacturers can also choose to replace 4- 5- and 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 planetary gear sets are added (which may be necessary in some cases to achieve the higher number of ratios), additional weight and friction are introduced. Also, the additional shifting of such a transmission can be perceived as bothersome to some consumers, so manufacturers need to develop strategies for smooth shifts. Some manufacturers are replacing 4- and 5-speed automatics with 6-speed automatics already, and 7- and 8-speed automatics have entered production in light-duty vehicles, albeit in lower-volume applications in luxury and performance oriented cars.

As discussed in the light-duty final GHG rule, confidential manufacturer data projected that 6-speed transmissions could incrementally reduce fuel consumption by 0 to 5 percent from a 4-speed automatic transmission, while an 8-speed transmission could incrementally reduce fuel consumption by up to 6 percent from a 4-speed automatic transmission. GM has publicly claimed a fuel economy improvement of up to 4 percent for its new 6-speed automatic transmissions.[161]

NHTSA and EPA reviewed and revised these effectiveness estimates based on actual usage statistics and testing methods for these vehicles along with confidential business information. When combined with improved automatic transmission control, the agencies estimate the effectiveness for a conversion from a 4 to a 6-speed transmission to be 5.3% and a conversion from a 6 to 8-speed transmission to be 1.7%. While 8-speed transmissions were not considered in the 2012–2016 light-duty final rule, they are considered as a technology of choice for this analysis in that manufacturers are expected to upgrade the 6-speed automatic transmissions being implemented today with 8-speed automatic transmissions in the 2014–2018 timeframe. For this proposal, we are estimating the cost of an 8-speed automatic transmission at $231 (2008$) relative to a 6-speed automatic transmission in the 2014 model year. This estimate is based from the 2010 NAS Report and we have applied a low complexity ICM of 1.17 and time based learning. This technology applies to both gasoline and diesel trucks and vans.

(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

[161] General Motors, news release, "From Hybrids to Six-Speeds, Direct Injection And More, GM's 2008 Global Powertrain Lineup Provides More Miles with Less Fuel" (released Mar. 6, 2007). Available at *http://www.gm.com/experience/fuel_economy/news/2007/adv_engines/2008-powertrain-lineup-082707.jsp* (last accessed Sept. 18, 2008).

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.

The 2012–2016 light-duty final rule estimated a 1 to 2 percent effectiveness based on the 2002 NAS report for light-duty vehicle technologies, a Sierra Research report, and confidential manufacturer data. NHTSA and EPA reviewed these effectiveness estimates and found them to be accurate, thus they have been retained for purposes of this NPRM.

NHTSA and EPA adjusted the EPS cost for the current rulemaking based on a review of the specification of the system. Adjustments were made to include potentially higher voltage or heavier duty system operation for HD pickups and vans. Accordingly, higher costs were estimated for systems with higher capability. After accounting for the differences in system capability and applying the ICM markup of low complexity technology of 1.17, the estimated costs for this proposal are $108 for a MY 2014 truck or van (2008$). As EPS systems are in widespread usage today, time-based learning is deemed applicable. EHPS systems are considered to be of equal cost and both are considered applicable to gasoline and diesel engines.

(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 starting of the engine. Further benefit may be obtained when electrification is combined with an improved, higher efficiency engine alternator. Intelligent cooling can more easily be applied to vehicles that do not typically carry heavy payloads, so larger vehicles with towing capacity present a challenge, as these vehicles have high cooling fan loads.[162]

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 for this proposal.

NHTSA and EPA jointly reviewed the estimates of 1 to 2 percent effectiveness estimates used in the 2012–2016 light-duty final rule and found them to be accurate for Improved Electrical Accessories. Consistent with the 2012–2016 light-duty final rule, the agencies have estimated the cost of this technology at $88 (2008$) including a low complexity ICM of 1.17. This cost is applicable in the 2014 model year. Improved accessory systems are in production currently and thus time-based learning is applied. This technology was considered for diesel trucks and vans only.

(e) Vehicle Technologies

(i) Mass Reduction

Reducing a vehicle’s mass, or down-weighting the vehicle, decreases fuel consumption by reducing the energy demand needed to overcome forces resisting motion, and rolling resistance. Manufacturers employ a systematic approach to mass reduction, where the net mass reduction is the addition of a direct component or system mass reduction plus the additional mass reduction taken from indirect ancillary systems and components, as a result of full vehicle optimization, effectively compounding or obtaining a secondary mass reduction from a primary mass reduction. For example, use of a smaller, lighter engine with lower torque-output subsequently allows the use of a smaller, lighter-weight transmission and drive line components. Likewise, the compounded weight reductions of the body, engine and drivetrain reduce stresses on the suspension components, steering components, wheels, tires and brakes, allowing further reductions in the mass of these subsystems. The reductions in unsprung masses such as brakes, control arms, wheels and tires further reduce stresses in the suspension mounting points. This produces a compounding effect of mass reductions.

Estimates of the synergistic effects of mass reduction and the compounding effect that occurs along with it can vary significantly from one report to another. For example, in discussing its estimate, an Auto-Steel Partnership report states that “These secondary mass changes can be considerable—estimated at an additional 0.7 to 1.8 times the initial mass change.”§[163] This means for each one pound reduction in a primary component, up to 1.8 pounds can be reduced from other structures in the vehicle (*i.e.*, a 180 percent factor). The report also discusses that a primary variable in the realized secondary weight reduction is whether or not the powertrain components can be included in the mass reduction effort, with the lower end estimates being applicable when powertrain elements are unavailable for mass reduction. However, another report by the Aluminum Association, which primarily focuses on the use of aluminum as an alternative material for steel, estimated a factor of 64 percent for secondary mass reduction even though some powertrain elements were considered in the analysis.[164] That report also notes that typical values for this factor vary from 50 to 100 percent. Although there is a wide variation in stated estimates, synergistic mass reductions do exist, and the effects result in tangible mass reductions. Mass reductions in a single vehicle component, for example a door side impact/intrusion system, may actually result in a significantly higher weight savings in the total vehicle, depending on how well the manufacturer integrates the modification into the overall vehicle design. Accordingly, care must be taken when reviewing reports on weight reduction methods and practices to ascertain if compounding effects have been considered or not.

[162] 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.

[163] “Preliminary Vehicle Mass Estimation Using Empirical Subsystem Influence Coefficients,” Malen, D.E., Reddy, K. Auto-Steel Partnership Report, May 2007, Docket EPA–HQ–OAR–2009–0472–0169. Accessed on the Internet on May 30, 2009 at: *http://www.a-sp.org/database/custom/Mass%20Compounding%20-%20Final%20Report.pdf.*

[164] “Benefit Analysis: Use of Aluminum Structures in Conjunction with Alternative Powertrain Technologies in Automobiles,” Bull, M. Chavali, R., Mascarin, A., Aluminum Association Research Report, May 2008, Docket EPA–HQ–OAR–2009–0472–0168. Accessed on the Internet on April 30, 2009 at: *http://www.autoaluminum.org/downloads/IBIS–Powertrain-Study.pdf.*

Mass reduction is broadly applicable across all vehicle subsystems including the engine, exhaust system, transmission, chassis, suspension, brakes, body, closure panels, glazing, seats and other interior components, engine cooling systems and HVAC systems. It is estimated that up to 1.25 kilograms of secondary weight savings can be achieved for every kilogram of weight saved on a vehicle when all subsystems are redesigned to take into account the initial primary weight savings.[165 166]

Mass reduction can be accomplished by proven methods such as:

• *Smart Design:* Computer aided engineering (CAE) tools can be used to better optimize load paths within structures by reducing stresses and bending moments applied to structures. This allows better optimization of the sectional thicknesses of structural components to reduce mass while maintaining or improving the function of the component. Smart designs also integrate separate parts in a manner that reduces mass by combining functions or the reduced use of separate fasteners. In addition, some "body on frame" vehicles are redesigned with a lighter "unibody" construction.

• *Material Substitution:* Substitution of lower density and/or higher strength materials into a design in a manner that preserves or improves the function of the component. This includes substitution of high-strength steels, aluminum, magnesium or composite materials for components currently fabricated from mild steel.

• *Reduced Powertrain Requirements:* Reducing vehicle weight sufficiently allows for the use of a smaller, lighter and more efficient engine while maintaining or increasing performance. Approximately half of the reduction is due to these reduced powertrain output requirements from reduced engine power output and/or displacement, changes to transmission and final drive gear ratios. The subsequent reduced rotating mass (*e.g.*, transmission, driveshafts/halfshafts, wheels and tires) via weight and/or size reduction of components are made possible by reduced torque output requirements.

• Automotive companies have largely used weight savings in some vehicle subsystems to offset or mitigate weight gains in other subsystems from increased feature content (sound insulation, entertainment systems, improved climate control, panoramic roof, *etc.*).

• Lightweight designs have also been used to improve vehicle performance parameters by increased acceleration performance or superior vehicle handling and braking.

Many manufacturers have already announced proposed future products plans reducing the weight of a vehicle body through the use of high strength steel body-in-white, composite body panels, magnesium alloy front and rear energy absorbing structures reducing vehicle weight sufficiently to allow a smaller, lighter and more efficient engine. Nissan will be reducing average vehicle curb weight by 15% by 2015.[167] Ford has identified weight reductions of 250 to 750 lb per vehicle as part of its implementation of known technology within its sustainability strategy between 2011 and 2020.[168] Mazda plans to reduce vehicle weight by 220 pounds per vehicle or more as models are redesigned. [169, 170] Ducker International estimates that the average curb weight of light-duty vehicle fleet will decrease approximately 2.8% from 2009 to 2015 and approximately 6.5% from 2009 to 2020 via changes in automotive materials and increased change-over from previously used body-on-frame automobile and light-truck designs to newer unibody designs.167 While the opportunity for mass reductions available to the light-duty fleet may not in all cases be applied directly to the heavy-duty fleet due to the different designs for the expected duty cycles of a "work" vehicle, mass reductions are still available particularly to areas unrelated to the components necessary for the work vehicle aspects.

Due to the payload and towing requirements of these heavy-duty vehicles, engine downsizing was not considered in the estimates for CO_2 reduction in the area of mass reduction/ material substitution. NHTSA and EPA estimate that a 3 percent mass reduction with no engine downsizing results in a 1 percent reduction in fuel consumption. In addition, a 5 and 10 percent mass reduction with no engine downsizing result in an estimated CO_2 reduction of 1.6 and 3.2 percent respectively. These effectiveness values are 50% of the 2012–2016 light-duty final rule values due to the elimination of engine downsizing for this class of vehicle.

Consistent with the 2012–2016 light-duty final rule, the agencies have estimated the cost of mass reduction at $1.32 per pound (2008$). For this analysis, the agencies are estimating a 5% mass reduction or, given the baseline weight of current trucks and vans, are estimating costs of $462, $544, $513, and $576 for Class 2b gasoline, 2b diesel, 3 gasoline, 3 diesel trucks and vans, respectively. All values are in 2008 dollars, are applicable in the 2014 model year and include a low complexity ICM of 1.17. Time based learning is considered applicable to mass reduction technologies.

The agencies have recently completed work on an Interim Joint Technical Assessment Report that considers light-duty GHG and fuel economy standards for the years 2017 through 2025.[171] In that report, the agencies have used updated cost estimates for mass reduction which were not available in time for use in this analysis but could be used in the final analysis. The agencies request comment on which mass reduction costs—those used in this draft analysis or those used in the Joint Technical Assessment Report—would be most appropriate for Class 2b & 3 trucks and vans along with supporting information.

(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

[165] "Future Generation Passenger Compartment-Validation (ASP 241)" Villano, P.J., Shaw, J.R., Polewarczyk, J., Morgans, S., Carpenter, J.A., Yocum, A.D., in "Lightweighting Materials—FY 2008 Progress Report," U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Program, May 2009, Docket EPA–HQ–OAR–2009–0472–0190.

[166] "Preliminary Vehicle Mass Estimation Using Empirical Subsystem Influence Coefficients," Malen, D.E., Reddy, K. Auto-Steel Partnership Report, May 2007, Docket EPA–HQ–OAR–2009–0472–0169. Accessed on the Internet on May 30, 2009 at: *http://www.a-sp.org/database/custom/Mass%20Compounding%20-%20Final%20Report.pdf.*

[167] "Lighten Up!," Brooke, L., Evans, H. Automotive Engineering International, Vol. 117, No. 3, March 2009.

[168] "2008/9 Blueprint for Sustainability," Ford Motor Company. Available at: *http://www.ford.com/go/sustainability* (last accessed February 8, 2010).

[169] "Mazda to cut vehicle fuel consumption 30 percent by 2015," Mazda press release, June 23, 2009. Available at: *http://www.mazda.com/publicity/release/2008/200806/080623.html*(last accessed February 8, 2010).

[170] "Mazda: Don't believe hot air being emitted by hybrid hype," Greimel, H. Automotive News, March 30, 2009.

[171] "Interim Joint Technical Assessment Report: Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2017–2025;" September 2010; available at *http://epa.gov/otaq/climate/regulations/ldv-ghg-tar.pdf* and in the docket for this rule.

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 additional changes to suspension tuning and/or suspension design.

EPA and NHTSA estimated a 1 to 2 percent increase in effectiveness with a 10 percent reduction in rolling resistance, which was based on the 2010 NAS Report findings and consistent with the 2012–2016 light-duty final rule.

Based on the 2012–2016 light-duty final rule and the 2010 NAS Report, the agencies have estimated the cost for LRR tires to be $6 per Class 2b truck or van, and $9 per Class 3 truck or van.[172] The higher cost for the Class 3 trucks and vans is due to the predominant use of dual rear tires and, thus, 6 tires per truck. Due to the commodity-based nature of this technology, cost learning is not applied. This technology is considered applicable to both gasoline and diesel.

(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.

The 2012–2016 light-duty final rule estimated that a fleet average of 10 to 20 percent total aerodynamic drag reduction is attainable which equates to incremental reductions in fuel consumption and CO_2 emissions of 2 to 3 percent for both cars and trucks. These numbers are generally supported by confidential manufacturer data and public technical literature. For the heavy-duty truck category, a 5 to 10 percent total aerodynamic drag reduction was considered due to the different structure and use of these vehicles equating to incremental reductions in fuel consumption and CO_2 emissions of 1 to 2 percent.

Consistent with the 2012–2016 light-duty final rule, the agencies have estimated the cost for this technology at $54 (2008$) including a low complexity ICM of 1.17. This cost is applicable in the 2014 model year to both gasoline and diesel trucks and vans.

(3) What are the projected technology packages' effectiveness and cost?

The assessment of the proposed technology effectiveness was developed through the use of the EPA Lumped Parameter model developed for the light-duty rule. Many of the technologies were common with the light-duty assessment but the effectiveness of individual technologies was appropriately adjusted to match the expected effectiveness when implemented in a heavy-duty application. The model then uses the individual technology effectiveness levels but then takes into account technology synergies. The model is also designed to prevent double counting from technologies that may directly or indirectly impact the same physical attribute (*e.g.*, pumping loss reductions).

To achieve the levels of the proposed standards for gasoline and diesel powered heavy-duty vehicles, the technology packages were determined to generally require the technologies previously discussed respective to unique gasoline and diesel technologies. 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 shows that some vehicle models will 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 pickup trucks and vans are shown in Table III–11.

[172] "Tires and Passenger Vehicle Fuel Economy," Transportation Research Board Special Report 286, National Research Council of the National Academies, 2006, Docket EPA–HQ–OAR–2009–0472–0146.

Table III-11 Technology Costs for HD Pickup Trucks & Vans Inclusive of Indirect Cost Markups for the 2014MY (2008$)

Technology	Class 2b Gasoline	Class 2b Diesel	Class 3 Gasoline	Class 3 Diesel
Low friction lubes	$4	$4	$4	$4
Engine friction reduction	$108	N/A	$108	N/A
Coupled cam phasing	$46	N/A	$46	N/A
Cylinder deactivation	$193	N/A	$193	N/A
Stoichiometric gasoline direct injection	$395	N/A	$395	N/A
Engine improvements	N/A	$172	N/A	$172
8s automatic transmission (increment to 6s automatic transmission)	$231	$231	$231	$231
Improved accessories	N/A	$88	N/A	$88
Low rolling resistance tires	$6	$6	$9	$9
Aerodynamic improvements	$54	$54	$54	$54
Electric (or electro/hydraulic) power steering	$108	$108	$108	$108
Aftertreatment improvements	N/A	$110	N/A	$110
Mass reduction (5%)	$462	$544	$513	$576
Air conditioning	$21	$21	$21	$21
Total	$1,628	$1,338	$1,683	$1,373
At 15% phase-in in 2014	$244	$201	$252	$206

(4) Reasonableness of the Proposed Standards

The proposed standards are based on the application of the control technologies described in this section. These technologies are available within the lead time provided, as discussed in draft RIA Chapter 2.3. These controls are estimated to add costs of approximately $1,249 to $1,592 for MY 2018 heavy-duty pickups and vans. Reductions associated with these costs and technologies are considerable, estimated at a 12 percent reduction of CO_2eq emissions from the MY 2010 baseline for gasoline engine-equipped vehicles and 17 percent for diesel engine equipped vehicles, estimated to result in reductions of 21 MMT of CO_2eq emissions over the lifetimes of 2014 through 2018 MY vehicles.[173] The reductions are cost effective, estimated at $100 per ton of CO_2eq removed in 2030.[174] This cost is consistent with the light-duty rule which was estimated at $100 per ton of CO_2eq removed in 2020 excluding fuel savings. Moreover, taking into account the fuel savings associated with the program, the cost becomes −$200 per ton of CO_2eq in 2030. The cost of controls is fully recovered due to the associated fuel savings, with a payback period within the fifth and sixth year of ownership, as shown in Table VIII–6 below. Given the large, cost effective emission reductions based on use of feasible technologies which are available in the lead time provided, plus the lack of adverse impacts on vehicle safety or utility, EPA and NHTSA regard these proposed standards as appropriate and consistent with our respective statutory authorities under CAA section 202(a) and NHTSA's EISA authority under 49 U.S.C. 32902(k)(2).

C. Class 2b–8 Vocational Vehicles

Vocational vehicles cover a wide variety of applications which influence both the body style and usage patterns. They also are built using a complex process, which includes additional parties such as body builders. These factors have led the agencies to propose a vehicle standard for vocational vehicles for the first phase of the program that relies on less extensive addition of technology as well as focusing on the chassis manufacturer as the manufacturer subject to the standard. We believe that future rulemakings will consider increased stringency and possibly more application-specific standards. The agencies are proposing standards for the diesel and gasoline engines used in vocational vehicles, similar to those discussed above for Class 7 and 8 tractors.

(1) What technologies did the agencies consider to reduce the CO_2 emissions and fuel consumption of vocational vehicles?

Similar to the approach taken with tractors, the agencies evaluated aerodynamic, tire, idle reduction, weight reduction, hybrid powertrain, and engine technologies and their impact on reducing fuel consumption and GHG emissions. The engines used in vocational vehicles include both gasoline and diesel engines, thus, each type is discussed separately below. As explained in Section II.D.1.b, the proposed regulatory structure for heavy-duty engines separates the compression ignition (or "diesel") engines into three regulatory subcategories—light heavy, medium heavy, and heavy heavy diesel

[166] *See* Table VI–4.

[167] *See* Table VIII–3.

engines—while spark ignition (or "gasoline") engines are a single regulatory subcategory. Therefore, the subsequent discussion will assess each type of engine separately.

(a) Vehicle Technologies

Vocational vehicles typically travel fewer miles than combination tractors. They also tend to be used in more urban locations (with consequent stop and start drive cycles). Therefore the average speed of vocational vehicles is significantly lower than tractors. This has a significant effect on the types of technologies that are appropriate to consider for reducing CO_2 emissions and fuel consumption.

The agencies considered the type of technologies for vocational vehicles based on the energy losses of a typical vocational vehicle. The technologies are similar to the ones considered for tractors. Argonne National Lab conducted an energy audit using simulation tools to evaluate the energy losses of vocational vehicles, such as a Class 6 pickup and delivery truck. Argonne found that 74 percent of the energy losses are attributed to the engine, 13 percent to tires, 9 percent to aerodynamics, two percent to transmission losses, and the remaining four percent of losses to axles and accessories for a medium-duty truck traveling at 30 mph.[175]

Low 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 (as just mentioned). The range of rolling resistance of tires used on vocational vehicles today is large. 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 truck buyers to value tire traction and durability more heavily than rolling resistance. Therefore, the agencies concluded that a regulatory program that seeks to optimize tire rolling resistance in addition to traction and durability can bring about fuel consumption and CO_2 emission reductions from this segment. The 2010 NAS report states that rolling resistance impact on fuel consumption reduces with mass of the vehicle and with drive cycles with more frequent starts and stops. The report found that the fuel consumption reduction opportunity for reduced rolling resistance ranged between one and three percent in the 2010 through 2020 timeframe.[176] The agencies estimate that average rolling resistance from tires in 2010 model year can be reduced by 10 percent by 2014 model year based on the tire development achievements over the last several years in the line haul truck market which would lead to a 2 percent reduction in fuel consumption based on GEM.

Aerodynamics: The Argonne National lab work shows that aerodynamics have less of an impact on vocational vehicle energy losses than do engines or tires. In addition, the aerodynamic performance of a complete vehicle is significantly influenced by the body of the truck. The agencies are not proposing to regulate body builders in this phase of regulations for the reasons discussed in Section II. Therefore, we are not basing any of the proposed standards for vocational vehicles on aerodynamic improvements. Nor would aerodynamic performance be input into GEM to demonstrate compliance.

Weight Reduction: NHTSA and EPA are also not basing any of the proposed standards on use of vehicle weight reduction. Thus, vehicle mass reductions would not be input into GEM. The vocational vehicle models are not designed to be application-specific. Therefore weight reductions are difficult to quantify.

Drivetrain: Optimization of vehicle gearing to engine performance through selection of transmission gear ratios, final drive gear ratios and tire size can play a significant role in reducing fuel consumption and GHGs. Optimization of gear selection versus vehicle and engine speed accomplished through driver training or automated transmission gear selection can provide additional reductions. The 2010 NAS report found that the opportunities to reduce fuel consumption in heavy-duty vehicles due to transmission and driveline technologies in the 2015 timeframe ranged between 2 and 8 percent.[177] Initially, the agencies considered reflecting transmission choices and technology in our standard setting process for both tractors and vocational vehicles (*see* previous discussion above on automated transmissions for tractors). We have however decided not to do so for the following reasons.

The primary factors that determine optimum gear selection are vehicle weight, vehicle aerodynamics, vehicle speed, and engine performance typically considered on a two dimensional map of engine speed and torque. For a given power demand (determined by speed, aerodynamics and vehicle mass) an optimum transmission and gearing setup will keep the engine power delivery operating at the best speed and torque points for highest engine efficiency. Since power delivery from the engine is the product of speed and torque a wide range of torque and speed points can be found that deliver adequate power, but only a smaller subset will provide power with peak efficiency. Said more generally, the design goal is for the transmission to deliver the needed power to the vehicle while maintaining engine operation within the engine's "sweet spot" for most efficient operation. Absent information about vehicle mass and aerodynamics (which determines road load at highway speeds) it is not possible to optimize the selection of gear ratios for lowest fuel consumption. Truck and chassis manufacturers today offer a wide range of tire sizes, final gear ratios and transmission choices so that final bodybuilders can select an optimal combination given the finished vehicle weight, general aerodynamic characteristics and expected average speed. In order to set fuel efficiency and GHG standards that would reflect these optimizations, the agencies would need to regulate a wide range of small entities that are final bodybuilders, would need to set a large number of uniquely different standards to reflect the specific weight and aerodynamic differences and finally would need test procedures to evaluate these differences that would not themselves be excessively burdensome. Finally, the agencies would need the underlying data regarding effectively all of the vocational trucks produced today in order to determine the appropriate standards. Because the market is already motivated to reach these optimizations themselves today, because we have insufficient data to determine appropriate standards, and finally, because we believe the testing burden would be unjustifiably high, we are not proposing to reflect transmission and gear ratio optimization in our GEM model or in our standard setting.

We are broadly seeking comment on our reasons for not reflecting these technology choices including recommendations for ways that the agencies could effectively reflect transmission related improvements. The agencies welcome comment on transmission and driveline technologies

[175] Argonne National Lab. Evaluation of Fuel Consumption Potential of Medium and Heavy-duty Vehicles through Modeling and Simulation. October 2009. Page 89.

[176] *See* 2010 NAS Report, Note 111, page 146.

[177] *See* 2010 NAS Report, Note 111, pp 134 and 137.

specific to the vocational vehicle market that can achieve fuel consumption and GHG emissions reductions.

Idle Reduction: Episodic idling by vocational vehicles occurs during the workday, unlike the overnight idling of combination tractors. Vocational vehicle idling can be divided into two typical types. The first type is idling while waiting—such as during a pickup or delivery. This type of idling can be reduced through automatic engine shut-offs. The second type of idling is to accomplish PTO operation, such as compacting garbage or operating a bucket. The agencies have found only one study that quantifies the emissions due to idling conducted by Argonne National Lab based on 2002 VIUS data.[178] EPA conducted a work assignment to assist in characterizing PTO operations. The study of a utility truck used in two different environments (rural and urban) and a refuse hauler found that the PTO operated on average 28 percent of time relative to the total time spent driving and idling. The use of hybrid powertrains to reduce idling is discussed below.

Hybrid Powertrains: Several types of vocational vehicles are well suited for hybrid powertrains. 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 three types of hybrid powertrain systems—hydraulic, electric, and plug-in electric. The hybrids developed to date have seen fuel consumption and CO_2 emissions reductions between 20 and 50 percent in the field. However, there are still some key issues that are restricting the penetration of hybrids, including overall system cost, battery technology, and lack of cost-effective electrified accessories. The agencies are proposing to include hybrid powertrains as a technology to meet the vocational vehicle standard, as described in Section IV. However, the agencies are not proposing a vocational vehicle standard predicated on using a specific penetration of hybrids. We have not predicated the standards based on the use of hybrids reflecting the still nascent level of technology development and the very small fraction of vehicle sales they would be expected to account for in this timeframe—on the order of only a percent or two. Were we to overestimate the number of hybrids that could be produced, we would set a standard that is not feasible. We believe that it is more appropriate given the status of technology development and our high hopes for future advancements in hybrid technologies to encourage their production through incentives. The agencies welcome comments on this approach.

(b) Gasoline Engine Technologies

The gasoline (or spark ignited) engines certified and sold as loose engines into the heavy-duty truck market are typically large V8 and V10 engines produced by General Motors and Ford. The basic engine architecture of these engines is the same as the versions used in the heavy-duty pickup trucks and vans. Therefore, the technologies analyzed by the agencies mirror the gasoline engine technologies used in the heavy-duty pickup truck analysis in Section III.B above.

Building on the technical analysis underlying the 2012–2016 MY light-duty vehicle rule, the agencies took a fresh look at technology effectiveness values for purposes of this proposal using a starting point the estimates from that rule. The agencies then considered the impact of test procedures (such as higher test weight of HD pickup trucks and vans) on the effectiveness estimates. The agencies also considered other sources such as the 2010 NAS Report, recent CAFE compliance data, and confidential manufacturer estimates of technology effectiveness. NHTSA and EPA engineers 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.

The agencies note that the effectiveness values estimated for the technologies may represent average values, 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. For purposes of this NPRM, 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 engines) might obtain from adding a fuel-saving technology. However, the agencies seek comment on whether additional levels of specificity beyond that already provided would improve the analysis for the final rules, and if so, how those levels of specificity should be analyzed.

Baseline Engine: Similar to the gasoline engine used as the baseline in the light-duty GHG rule, the agencies assumed the baseline engine in this segment to be a naturally aspirated, overhead valve V8 engine. The following discussion of effectiveness is generally in comparison to 2010 baseline engine performance.

The technologies the agencies considered include the following:

Engine Friction Reduction: In addition to low friction lubricants, manufacturers can also reduce friction and improve fuel consumption by improving the design of engine components and subsystems. 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. The 2010 NAS, NESCCAF[179] and EEA[180] reports as well as confidential manufacturer data used in the light-duty vehicle rulemaking suggested a range of effectiveness for engine friction reduction to be between 1 to 3 percent. NHTSA and EPA continue to believe that this range is accurate.

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 a single overhead cam engine or an overhead valve engine. Based on the 2012–2016 MY light-duty vehicle rule, previously-received confidential manufacturer data, and the NESCCAF report, NHTSA and EPA estimated the effectiveness of couple cam phasing CCP to be between 1 and 4 percent. NHTSA and EPA reviewed this estimate for purposes of the NPRM, and continue to find it accurate.

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

[178] Gaines, Linda, A. Vyas, J. Anderson (Argonne National Laboratory). *Estimation of Fuel Use by Idling Commercial Trucks.* January 2006.

[179] Northeast States Center for a Clean Air Future. "Reducing Greenhouse Gas Emissions from Light-Duty Motor Vehicles." September 2004.

[180] Energy and Environmental Analysis, Inc. "Technology to Improve the Fuel Economy of Light Duty Trucks to 2015." May 2006.

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 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. Effectiveness improvements scale roughly with engine displacement-to-vehicle weight ratio—the higher displacement-to-weight vehicles, operating at lower relative loads for normal driving, have the potential to operate in part-cylinder mode more frequently. Therefore, the agencies reduced the effectiveness assumed from this technology for trucks because of the lower displacement-to-weight ratio relative to light-duty vehicles. NHTSA and EPA adjusted the 2010 light-duty vehicle final rule estimates using updated power to weight ratings of heavy-duty trucks and confidential business information and confirmed a range of 3 to 4 percent for these vehicles.

Stoichiometric gasoline direct injection: SGDI (also known as spark-ignition direct injection engines) inject fuel at high pressure directly into the combustion chamber (rather than the intake port in port fuel injection). 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. The 2012–2016 MY light-duty vehicle final rule estimated the effectiveness of SGDI to be between 2 and 3 percent. NHTSA and EPA revised these estimated accounting for the use and testing methods for these vehicles along with confidential business information estimates received from manufacturers while developing the proposal. Based on these revisions, NHTSA and EPA estimate the range of 1 to 2 percent for SGDI.

(c) Diesel Engine Technologies

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.

Baseline Engine: There are three baseline diesel engines, a Light, Medium, and a Heavy Heavy-duty Diesel engine. The agencies developed the baseline diesel engine as a 2010 model year engine with an aftertreatment system which meets EPA's 0.2 grams of NO_X/bhp-hr standard with an SCR system along with EGR and meets the PM emissions standard with a diesel particulate filter with active regeneration. The engine is turbocharged with a variable geometry turbocharger. The following discussion of technologies describes improvements over the 2010 model year baseline engine performance, unless otherwise noted. Further discussion of the baseline engine and its performance can be found in Section III.C.2.(c)(i) below. The following discussion of effectiveness is generally in comparison to 2010 baseline engine performance, and is in reference to performance in terms of the Heavy-duty FTP that would be used for compliance for these engine standards. This is in comparison to the steady state SET procedure that would be used for compliance purposes for the engines used in Class 7 and 8 tractors. *See* Section II.B.2.(i) above.

Turbochargers: Improved efficiency of a turbocharger compressor or turbine could reduce fuel consumption by approximately 1 to 2 percent over today's variable geometry turbochargers in the market today. The 2010 NAS report identified technologies such as higher pressure ratio radial compressors, axial compressors, and dual stage turbochargers as design paths to improve turbocharger efficiency.

Low Temperature Exhaust Gas Recirculation: Most LHDD, MHDD, and HHDD engines sold in the U.S. market today use cooled EGR, in which part of the exhaust gas is routed through a cooler (rejecting energy to the engine coolant) before being returned to the engine intake manifold. EGR is a technology employed to reduce peak combustion temperatures and thus NO_X. Low-temperature EGR uses a larger or secondary EGR cooler to achieve lower intake charge temperatures, which tend to further reduce NO_X formation. If the NO_X requirement is unchanged, low-temperature EGR can allow changes such as more advanced injection timing that will increase engine efficiency slightly more than one percent. Because low-temperature EGR reduces the engine's exhaust temperature, it may not be compatible with exhaust energy recovery systems such as turbocompound or a bottoming cycle.

Engine Friction Reduction: Reduced friction in bearings, valve trains, and the piston-to-liner interface will improve efficiency. Any friction reduction must be carefully developed to avoid issues with durability or performance capability. Estimates of fuel consumption improvements due to reduced friction range from 0.5 to 1.5 percent.[181]

Selective catalytic reduction: This technology is common on 2010 heavy-duty diesel engines. Because SCR is a highly effective NO_X aftertreatment approach, it enables engines to be optimized to maximize fuel efficiency, rather than minimize engine-out NO_X. 2010 SCR systems are estimated to result in improved engine efficiency of approximately 4 to 5 percent compared to a 2007 in-cylinder EGR-based emissions system and by an even greater percentage compared to 2010 in-cylinder approaches.[182] As more effective low-temperature catalysts are developed, the NO_X conversion efficiency of the SCR system will increase. Next-generation SCR systems could then enable still further efficiency improvements; alternatively, these advances could be used to maintain efficiency while down-sizing the aftertreatment. We estimate that continued optimization of the catalyst could offer 1 to 2 percent reduction in fuel use over 2010 model year systems in the 2014 model year.[183] The agencies also estimate that continued refinement and optimization of the SCR systems could provide an additional 2 percent reduction in the 2017 model year.

[181] TIAX, Assessment of Fuel Economy Technologies for Medium- and Heavy-duty Vehicles, Final Report, Nov. 19, 2009, pg. 4–15.

[182] Stanton, D. "Advanced Diesel Engine Technology Development for High Efficiency, Clean Combustion." Cummins, Inc. Annual Progress Report 2008 Vehicle Technologies Program: Advanced Combustion Engine Technologies, U.S. Department of Energy. Pp. 113–116. December 2008.

[183] TIAX Assessment of Fuel Economy Technologies for Medium and Heavy-duty Vehicles, Report to National Academy of Sciences, Nov 19, 2009, pg. 4–9.

Improved Combustion Process: Fuel consumption reductions in the range of 1 to 4 percent are identified in the 2010 NAS report through improved combustion chamber design, higher fuel injection pressure, improved injection shaping and timing, and higher peak cylinder pressures.[184]

Reduced Parasitic Loads: 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. 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.[185]

(2) What is the projected technology package's effectiveness and cost?

(a) Vocational Vehicles

(i) Baseline Vocational Vehicle Performance

The baseline vocational vehicle model is defined in GEM, as described in draft RIA Chapter 4.4.6. The agencies used a baseline rolling resistance coefficient for today's vocational vehicle fleet of 9 kg/metric ton.[186] Further vehicle technology is not included in this baseline, as discussed below in the discussion of the baseline vocational vehicle. The baseline engine fuel consumption represents a 2010 model year diesel engine, as described in draft RIA Chapter 4. Using these values, the baseline performance of these vehicles is included in Table III–12.

Table III-12: Baseline Vocational Vehicle Performance

	Vocational Vehicle		
	Light Heavy-Duty	Medium Heavy-Duty	Heavy Heavy-Duty
Fuel Consumption Baseline (gallon/1,000 ton-mile)	37.6	22.3	11.3
CO_2 Baseline (grams CO_2/ton-mile)	382	227	115

(ii) Vocational Vehicle Technology Package

The proposed program for vocational vehicles for this phase of regulatory standards is limited to performance of tire and engine technologies. Aerodynamics technology, weight reduction, drive train improvement, and hybrid power trains are not included for the reasons discussed above in Section III.C(1). The agencies are seeking comment on the appropriateness of this approach.

The assessment of the proposed technology effectiveness was developed through the use of the GEM. To account for the two proposed engine standards, EPA is proposing the use of a 2014 model year fuel consumption map in GEM to derive the 2014 model year truck standard and a 2017 model year fuel consumption map to derive the 2017 model year truck standard. (These fuel consumption maps reflect the main standards proposed for HD diesel engines, not the alternative standards.) EPA estimates that the rolling resistance of tires can be reduced by 10 percent in the 2014 model year. The vocational vehicle standards for all three regulatory categories were determined using a tire rolling resistance coefficient of 8.1 kg/metric ton with a 100 percent application rate by the 2014 model year. The set of input parameters which are modeled in GEM are shown in Table III–13.

Table III-13: GEM Inputs for Proposed Vocational Vehicle Standards

	2014 MY	2017 MY
Engine	2014 MY 7L for LHD/MHD and 15L for HHD Trucks	2017 MY 7L for LHD/MHD and 15L for HHD Trucks
Tire Rolling Resistance (kg/metric ton)	8.1	8.1

[184] *See* 2010 NAS Report, Note 111, page 56.

[185] TIAX. 2009. Pages 3–5.

[186] The baseline tire rolling resistance for this segment of vehicles was derived for the proposal based on the current baseline tractor and passenger car tires. The baseline tractor drive tire has a rolling resistance of 8.2 kg/metric ton based on SmartWay testing. The average passenger car has a tire rolling resistance of 9.75 kg/metric ton based on a presentation made to CARB by the Rubber Manufacturer's Association. Additional details are available in the draft RIA Chapter 2.

The agencies developed the proposed standards by using the engine and tire rolling resistance inputs in the GEM, as shown in Table III–13. The percent reductions shown in Table III–14 reflect improvements over the 2010 model year baseline vehicle with a 2010 model year baseline engine.

Table III-14: Proposed Vocational Vehicle Standards and Percent Reductions

	Vocational Vehicle		
	Light Heavy-Duty	Medium Heavy-Duty	Heavy Heavy-Duty
2016 MY Fuel Consumption Standard (gallon/1,000 ton-mile)	35.2	20.8	10.7
2017 MY Fuel Consumption Standard (gallon/1,000 ton-mile)	33.8	20.0	10.5
2014 MY CO_2 Standard (grams CO_2/ton-mile)	358	212	109
2017 MY CO_2 Standard (grams CO_2/ton-mile)	344	204	107
Percent Reduction from 2010 baseline in 2014 MY	6%	7%	6%
Percent Reduction from 2010 baseline in 2017 MY	10%	10%	7%

(iii) Technology Package Cost

EPA and NHTSA developed the costs of LRR tires based on the ICF report. The estimated cost per truck is $155 (2008$) for LHD and MHD trucks and $186 (2008$) for HHD trucks. These costs include a low complexity ICM of 1.14 and are applicable in the 2014 model year.

(iv) Reasonableness of the Proposed Standards

The proposed standards would not only add only a small amount to the vehicle cost, but are highly cost effective, an estimated $20 ton of CO_2eq per vehicle in 2030.[187] This is even less than the estimated cost effectiveness for CO_2eq removal under the light-duty vehicle rule, already considered by the agencies to be a highly cost effective reduction.[188] Moreover, the modest cost of controls is recovered almost immediately due to the associated fuel savings, as shown in the payback analysis included in Table VIII–7. Given that the standards are technically feasible within the lead time afforded by the 2014 model year, are inexpensive and highly cost effective, and do not have other adverse potential impacts (*e.g.,* there are no projected negative impacts on safety or vehicle utility), the proposed standards represent a reasonable choice under section 202(a) of the CAA and NHTSA's EISA authority under 49 U.S.C. 32902(k)(2), and the agencies believe that the standards are consistent with their respective authorities.

(v) Alternative Vehicle Standards Considered

The agencies are not proposing vehicle standards less stringent than the proposed standards because the agencies believe these standards are highly cost effective, as just explained.

The agencies considered proposing truck standards which are more stringent reflecting the inclusion of hybrid powertrains in those vocational vehicles where use of hybrid powertrains is appropriate. The agencies estimate that a 25 percent utilization rate of hybrid powertrains in MY 2017 vocational vehicles would add, on average, $30,000 to the cost of each vehicle and more than double the cost of the rule for this sector. *See* the draft RIA at Chapter 6.1.8. The emission reductions associated with these very high costs appear to be modest. *See* the draft RIA Table 6–14. In addition, the agencies are proposing flexibilities in the form of generally applicable credit opportunities for advanced technologies, to encourage use of hybrid powertrains. *See* Section IV.C.2 below. The agencies welcome comments on whether hybrid powertrain technologies are appropriate to consider for the 2017 model year standard, or if not, then when would they be appropriate.

(b) Gasoline Engines

(i) Baseline Gasoline Engine Performance

EPA and NHTSA developed the reference heavy-duty gasoline engines to represent a 2010 model year engine compliant with the 0.2 g/bhp-hr NO_X standard for on-highway heavy-duty engines.

NHTSA and EPA developed the baseline fuel consumption and CO_2 emissions for the gasoline engines from manufacturer reported CO_2 values used in the certification of non-GHG pollutants. The baseline engine for the analysis was developed to represent a 2011 model year engine, because this is the most current information available. The average CO_2 performance of the heavy-duty gasoline engines was 660 g/bhp-hour, which will be used as a baseline. The baseline gasoline engines are all stoichiometric port fuel injected V–8 engines without cam phasers or other variable valve timing technologies. While they may reflect some degree of static valve timing optimization for fuel efficiency they do not reflect the potential to adjust timing with engine speed.

(ii) Gasoline Engine Technology Package Effectiveness

The gasoline engine technology package includes engine friction reduction, coupled cam phasing, and SGDI to produce an overall five percent reduction from the reference engine based on the Heavy-duty Lumped Parameter model. The agencies are projecting a 100% application rate of

[187] *See* Section VIII.D.

[188] The light-duty rule had an estimated cost per ton of $50 when considering the vehicle program costs only and a cost of −$210 per ton considering the vehicle program costs along with fuel savings in 2030. *See* 75 FR 25515, Table III.H.3–1.

this technology package to the heavy-duty gasoline engines, which results in a CO_2 standard of 627 g/bhp-hr and a fuel consumption standard of 7.05 gallon/100 bhp-hr. As discussed in Section II.D.b.ii, the agencies propose that the gasoline engine standards begin in the 2016 model year based on the agencies' projection of the engine redesign schedules of the small number of engines in this category.

(iii) Gasoline Engine Technology Package Cost

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 BOM approach employed by NHTSA and EPA in the 2012–2016 LD rule. NHTSA and EPA are proposing to use the marked up gasoline engine technology costs developed for the HD Pickup Truck and Van segment because they are made by the same manufacturers (primarily by Ford and GM) and, the same products simply sold as loose engines rather than complete vehicles. Hence the engine cost estimates are fundamentally the same. The costs are summarized in Table III–15. The costs shown in Table III–15 include a low complexity ICM of 1.17 and are applicable in the 2016 model year. No learning effects are applied to engine friction reduction costs, while time based learning is considered applicable to both coupled cam phasing and SGDI.

Table III-15: Heavy-duty Gasoline Engine Technology Costs inclusive of Indirect Cost Markups (2008$)

	2016MY
Engine Friction Reduction	$88
Coupled Cam Phasing	$43
Stoichiometric Gas Direct Injection	$372
Total	$504

(iv) Reasonableness of the Proposed Standard

The proposed engine standards appear to be reasonable and consistent with the agencies' respective authorities. With respect to the 2016 MY standard, all of the technologies on which the standards are predicated have been demonstrated and their effectiveness is well documented. The proposal reflects a 100 percent application rate for these technologies. The costs of adding these technologies remain modest across the various engine classes as shown in Table III–15. Use of these technologies would add only a small amount to the cost of the vehicle,[189] and the associated reductions are highly cost effective, an estimated $30 per ton of CO_2eq per vehicle.[190] This is even more cost effective than the estimated cost effectiveness for CO_2eq removal and fuel economy improvement under the light-duty vehicle rule, already considered by the agencies to be a highly cost effective reduction.[191] Accordingly, EPA and NHTSA view these standards as reflecting an appropriate balance of the various statutory factors under section 202(a) of the CAA and under NHTSA's EISA authority at 49 U.S.C. 32902(k)(2).

(v) Alternative Gasoline Engine Standards Considered

The agencies are not proposing gasoline standards less stringent than the proposed standards because the agencies believe these standards are feasible in the lead time provided, inexpensive, and highly cost effective. We welcome comments supplemented with data on each aspect of this determination most importantly on individual gasoline engine technology efficacy to reduce fuel consumption and GHGs as well was our estimates of individual technology cost and lead-time.

The proposed rule reflects 100 percent penetration of the technology package on whose performance the standard is based, so some additional technology would need to be added to obtain further improvements. The agencies considered proposing gasoline engine standards which are more stringent reflecting the inclusion of cylinder deactivation and other advanced technologies. However, the agencies are not proposing this level of stringency because our assessment is that these technologies would not be available for production by the 2017 model year. The agencies welcome comments on whether other gasoline technologies are appropriate to consider for the 2017 model year standard, or if not, then when would they be appropriate.

(c) Diesel Engines

(i) Baseline Diesel Engine Performance

EPA and NHTSA developed the baseline heavy-duty diesel engines to represent a 2010 model year engine compliant with the 0.2 g/bhp-hr NO_X standard for on-highway heavy-duty engines.

The agencies utilized 2007 through 2011 model year CO_2 certification levels from the Heavy-duty FTP cycle as the basis for the baseline engine CO_2 performance. The pre-2010 data are subsequently adjusted to represent 2010 model year engine maps by using predefined technologies including SCR and other systems that are being used in current 2010 production. The engine CO_2 results were then sales weighted within each regulatory subcategory to develop an industry average 2010 model year reference engine, as shown in Table III–16. The level of CO_2 emissions and fuel consumption of these engines varies significantly, where the engine with the highest CO_2 emissions is estimated to be 20 percent greater than the sales weighted average. Details of this analysis are included in draft RIA Chapter 2.

[189] Sample 2010 MY vocational vehicles range in price between $40,000 for a Class 4 work truck to approximately $200,000 for a Class 8 refuse hauler. *See* pages 16–17 of ICF's "Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for Heavy-Duty On-Road Vehicles." July 2010.

[190] *See* Vocational Vehicle CO_2 savings and technology costs for Alternative 2 in Section IX.B.

[191] The light-duty rule had an estimated cost per ton of $50 when considering the vehicle program costs only and a cost of −$210 per ton considering the vehicle program costs along with fuel savings in 2030. *See* 75 FR 25515, Table III.H.3–1.

Table III-16: 2010 Model Year Reference Diesel Engine Performance Over the Heavy-duty FTP Cycle

	CO_2 Emissions (g/bhp-hr)	Fuel Consumption (gallon/100 bhp-hr)
LHD Diesel	630	6.19
MHD Diesel	630	6.19
HHD Diesel	584	5.74

(ii) Diesel Engine Packages

The diesel engine technology packages for the 2014 model year include engine friction reduction, improved aftertreatment effectiveness, improved combustion processes, and low temperature EGR system optimization. The improvements in parasitic and friction losses come through piston designs to reduce friction, improved lubrication, and improved water pump and oil pump designs to reduce parasitic losses. The aftertreatment improvements are available through lower backpressure of the systems and optimization of the engine-out NO_X levels. Improvements to the EGR system and air flow through the intake and exhaust systems, along with turbochargers can also produce engine efficiency improvements. It should be pointed out that individual technology improvements are not additive to each other due to the interaction of technologies. The agencies assessed the impact of each technology over the Heavy-duty FTP and project an overall cycle improvement in the 2014 model year of 3 percent for HHD diesel engines and 5 percent for LHD and MHD diesel engines, as detailed in draft RIA Chapter 2.4.2.9 and 2.4.2.10. EPA used a 100 percent application rate of this technology package to determine the level of the proposed 2014 MY standards

Recently, EPA's heavy-duty highway engine program for criteria pollutants provided new emissions standards for the industry in three year increments. The heavy-duty engine manufacturer product plans have fallen into three year cycles to reflect this environment. EPA is proposing set CO_2 emission standards recognizing the opportunity for technology improvements over this timeframe while reflecting the typical heavy-duty engine manufacturer product plan cycles. Thus, the agencies are proposing to establish initial standards for the 2014 model year and a more stringent standard for heavy-duty engines beginning in the 2017 model year.

The 2017 model year technology package for LHD and MHD diesel engine includes continued development and refinement of the 2014 model year technology package, in particular the additional improvement to aftertreatment systems. This package leads to a projected 9 percent reduction for LHD and MHD diesel engines in the 2017 model year. The HHD diesel engine technology packages for the 2017 model year include the continued development of the 2014 model year technology package plus turbocompounding. A similar approach to evaluating the impact of individual technologies as taken to develop the overall reduction of the 2014 model year package was taken with the 2017 model year package. The Heavy-duty FTP cycle improvements lead to a 5 percent reduction on the cycle for HHDD, as detailed in draft RIA Chapter 2.4.2.13. The agencies used a 100 percent application rate of the technology package to determine the proposed 2017 MY standards. The agencies believe that bottom cycling technologies are still in the development phase and will not be ready for production by the 2017 model year.[192] Therefore, these technologies were not included in determining the stringency of the proposed standards. However, we do believe the bottoming cycle approach represents a significant opportunity to reduce fuel consumption and GHG emissions in the future. EPA and NHTSA are therefore both proposing provisions described in Section IV to create incentives for manufacturers to continue to invest to develop this technology.

The overall projected improvements in CO_2 emissions and fuel consumption over the baseline are included in Table III–17.

Table III-17: Percent Fuel Consumption and CO_2 Emission Reductions Over the Heavy-duty FTP Cycle

	2014	2017
LHD Diesel	5%	9%
MHD Diesel	5%	9%
HHD Diesel	3%	5%

(iii) Technology Package Costs

NHTSA and EPA jointly developed costs associated with the engine technologies to assess an overall package cost for each regulatory category. Our engine cost estimates for diesel engines used in vocational vehicles include a separate analysis of the incremental part costs, research and development activities, and additional equipment, such as emissions equipment to measure N_2O emissions. Our general approach used elsewhere in this proposal (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

[192] TIAX noted in their report to the NAS panel that the engine improvements beyond 2015 model year included in their report are highly uncertain, though they include waste heat recovery in the engine package for 2016 through 2020 (page 4–29).

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 we can make a more accurate estimate of technology cost using this alternate approach because the primary cost is not expected to be 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 believe it more accurate to directly estimate the indirect costs. 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 will 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 large part via technology changes that are not reflected in new hardware but rather 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.

The agencies developed the engineering costs for the research and development of diesel engines with lower fuel consumption and CO_2 emissions. The aggregate costs for engineering hours, technician support, dynamometer cell time, and fabrication of prototype parts are estimated at $6,750,000 per manufacturer per year over the five years covering 2012 through 2016. In aggregate, this averages out to $280 per engine during 2012 through 2016 using a very rough annual sales value of 600,000 LHD, MHD and HHD diesel engines. The agencies also are estimating costs of $100,000 per engine manufacturer per engine class (LHD, MHD and HHD diesel) to cover the cost of purchasing photo-acoustic measurement equipment for two engine test cells. This would be a one-time cost incurred in the year prior to implementation of the standard (*i.e.,* the cost would be incurred in 2013). In aggregate, this averages out to $4 per engine in 2013 using a very rough annual sales value of 600,000 LHD, MHD and HHD diesel engines.

EPA also developed the incremental piece cost for the components to meet each of the 2014 and 2017 standards. These costs shown in Table III–18 which include a low complexity ICM of 1.11; time based learning is considered applicable to each technology.

Table III-18: Heavy-duty Diesel Engine Component Costs inclusive of Indirect Cost Markups (2008$)

	2014 Model Year	2017 Model Year
Cylinder Head (flow optimized, increased firing pressure, improved thermal management)	$6 (MHD & HH) $10 (LHD)	$6 (MHD & HHD) $9 (LHD)
Exhaust Manifold (flow optimized, improved thermal management)	$0	$0
Turbocharger (improved efficiency)	$17	$16
EGR Cooler (improved efficiency)	$3	$3
Water Pump (optimized, variable vane, variable speed)	$87	$79
Oil Pump (optimized)	$4	$4
Fuel Pump (higher working pressure, increased efficiency, improved pressure regulation)	$4	$4
Fuel Rail (higher working pressure)	$10 (MHD & HHD) $11 (LHD)	$9 (MHD & HHD) $10 (LHD)
Fuel Injector (optimized, improved multiple event control, higher working pressure)	$10 (MHD & HHD) $14 (LHD)	$9 (MHD & HHD) $13 (LHD)
Piston (reduced friction skirt, ring and pin)	$3	$2
Aftertreatment system (improved effectiveness SCR, dosing, dpf)[a]	$0 (MHD & HHD) $111 (LHD)	$0 (MHD & HHD) $101 (LHD)
Valve Train (reduced friction, roller tappet)	$78 (MHD) $104 (LHD)	$71 (MHD) $95 (LHD)

Note:
[a] Note that costs for aftertreatment improvements for MHD and HHD diesel engines are covered via the engineering costs (see text). For LH diesel engines, we have included the cost of aftertreatment improvements as a technology cost.

The overall costs for each diesel engine regulatory subcategory are included in Table III–19.

Table III-19: Diesel Engine Technology Costs per Engine (2008$)

	2014	2017
LHD Diesel	$369	$337
MHD Diesel	$223	$203
HHD Diesel	$145	$132

(iv) Reasonableness of the Proposed Standards

The proposed engine standards appear to be reasonable and consistent with the agencies' respective authorities. With respect to the 2014 and 2017 MY standards, all of the technologies on which the standards have already been demonstrated and their effectiveness is well documented. The proposal reflects a 100 percent application rate for these technologies. The costs of adding these technologies remain modest across the various engine classes as shown in Table III–19. Use of these technologies would add only a small amount to the cost of the vehicle,[193] and the associated reductions are highly cost effective, an estimated $30 per ton of CO_2eq per vehicle.[194] This is even more cost effective than the estimated cost effectiveness for CO_2eq removal and fuel economy improvement under the light-duty vehicle rule, already considered by

[193] Sample 2010 MY vocational vehicles range in price between $40,000 for a Class 4 work truck to approximately $200,000 for a Class 8 refuse hauler. *See* pages 16–17 of ICF's "Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for Heavy-Duty On-Road Vehicles." July 2010.

[194] *See* Vocational Vehicle CO_2 savings and technology costs for Alternative 2 in Section IX.B.

the agencies to be a highly cost effective reduction.[195] Accordingly, EPA and NHTSA view these standards as reflecting an appropriate balance of the various statutory factors under section 202(a) of the CAA and under NHTSA's EISA authority at 49 U.S.C. 32902(k)(2).

(v) Alternative Diesel Engine Standards Considered

Other than the specific proposal related to legacy engine products, the agencies are not proposing diesel engine standards less stringent than the proposed standards because the agencies believe these standards are highly cost effective. We welcome comments supplemented with data on each aspect of this determination most importantly on individual engine technology efficacy to reduce fuel consumption and GHGs as well as our estimates of individual technology cost and lead-time.

The agencies considered proposing diesel engine standards which are more stringent reflecting the inclusion of other advanced technologies. However, the agencies are not proposing this level of stringency because our assessment is that these technologies would not be available for production by the 2017 model year. The agencies welcome comments on whether other diesel engine technologies are appropriate to consider for the 2017 model year standard, or if not, then when would they be appropriate.

IV. Proposed Regulatory Flexibility Provisions

This section discusses proposed flexibility provisions intended to achieve the goals of the overall program while providing alternate pathways to achieve those goals. The primary flexibility provisions the agencies are proposing for combination tractors and vocational vehicles relate to a program of Averaging, Banking, and Trading of credits that EPA and NHTSA are proposing in association with each agency's respective CO_2 and fuel consumption standards (*see* Section II above). For HD pickups and vans, the primary flexibility provision is the fleet averaging program patterned after the LD GHG and CAFE rule. EPA is not proposing an emission credit program associated with the proposed N_2O, CH_4, or HFC standards. This section also describes proposed flexibility provisions that would apply in specific circumstances.

A. Averaging, Banking, and Trading Program

Averaging, Banking, and Trading (ABT) of emissions credits have been an important part of many EPA mobile source programs under CAA Title II, including engine and vehicle programs. ABT programs can be important because they can help to address many issues of technological feasibility and lead-time, as well as considerations of cost. ABT programs are not just add-on provisions included to help reduce costs, but are usually an integral part of the standard setting itself. An ABT program is important because it provides manufacturers flexibilities that assist the development and implementation of new technologies efficiently and therefore enables new technologies to be implemented at a more progressive pace than without ABT. A well-designed ABT program can provide important environmental benefits and at the same time increase flexibility for and reduce costs to the regulated industry.

Section II above describes EPA's proposed GHG emission standards and NHTSA's proposed fuel consumption standards. For each of these respective sets of standards, the agencies are also proposing ABT provisions consistent with each agency's statutory authority. The agencies have worked closely together to design these proposed provisions to be essentially identical to each other in form and function. Because of this fundamental similarity, the remainder of this section refers to these provisions collectively as "the ABT program" except where agency-specific distinctions are required.

As discussed in detail below, the structure of this proposed GHG ABT program for HD engines is based closely on earlier ABT programs for HD engines; the proposed program for HD pickups and vans is built on the existing light-duty GHG program flexibility provisions; and we propose first-time ABT provisions for combination tractors and vocational vehicles that are as consistent as possible with our other HD vehicle regulations. The flexibility provisions associated with this new regulatory category are intended to systematically build upon the structure of the existing programs.

As an overview, "averaging" means the exchange of emission credits between engine families or truck families within a given manufacturer's regulatory subcategory. For example within each regulatory subcategory, engine manufacturers divide their product line into "engine families" that are comprised of engines expected to have similar emission characteristics throughout their useful life. Averaging allows a manufacturer to certify one or more engine families within the same regulatory subcategory at levels above the applicable emission standard. The increased emissions over the standard would need to be offset by one or more engine families within that manufacturer's regulatory subcategory that are certified below the same emission standard, such that the average emissions from all the manufacturer's engine families, weighted by engine power, regulatory useful life, and production volume, are at or below the level of the emission standard. (The inclusion of engine power, useful life, and production volume in the averaging calculations allows the emissions credits or debits to be expressed in total emissions over the useful life of the credit-using or generating engine sales.) Total credits for each regulatory subcategory within each model year are determined by summing together the credits calculated for every engine family within that specific regulatory subcategory.

"Banking" means the retention of emission credits by the manufacturer for use in future model year averaging or trading. "Trading" means the exchange of emission credits between manufacturers, which can then be used for averaging purposes, banked for future use, or traded to another manufacturer.

In the current HD program for criteria pollutants, manufacturers are restricted to only averaging, banking and trading credits generated within a regulatory subcategory, and we are proposing to continue this restriction in the GHG and fuel consumption program. However, the agencies are evaluating—and therefore request comment on—potential alternative approaches in which fewer restrictions are placed on the use of credits for averaging, banking, and trading. Particularly, the agencies request comment on removing prohibitions on averaging and trading between some or all regulatory categories in this proposal, and on removing restrictions between some or all regulatory subcategories that are within the same regulatory category (*e.g.,* allowing trading of credits between class 7 day cabs and class 8 sleeper cabs).

In the past, we have followed the practice of allowing averaging and trading between like products because we have recognized that the estimation of emissions credits is not an absolutely precise process, and actual emissions reductions or increases "in use" would vary due to differences in vehicle duty cycles, maintenance practices and any

[195] The light-duty rule had a cost per ton of $50 when considering the vehicle program costs only and a cost of −$210 per ton considering the vehicle program costs along with fuel savings in 2030. *See* 75 FR 25515, Table III.H.3–1.

number of other factors. By restricting credit averaging and trading to only allow averaging and trading between like products, the agencies gain some degree of assurance that the operation and use of the vehicles generating credits and consuming credits would be similar. The agencies also note that some industry participants have expressed concern that allowing credit averaging, banking and trading across different products may create an unlevel playing field for the regulated industry. Specifically, engine and truck manufacturers have commonly expressed to us a concern that some manufacturers with a wide range of product offerings spanning a number of regulatory categories would be able to use the ABT program provisions to generate credits in regulatory class markets where they face less competition and then use those credits to compete unfairly in other regulatory categories where they face greater competition. Finally, in the context of regulating criteria pollutants that can have localized and regional impacts, we have been concerned about the unintended consequence of unrestricted credit averaging or trading on local or regional concentrations of pollutants, whereby emissions reductions might become concentrated in some localities or regions to the detriment of other areas needing the reductions.

The agencies are evaluating the possibility of placing fewer restrictions on averaging and trading because increasing the flexibility offered to manufacturers to average, bank, and trade credits across regulatory subcategories and categories could potentially significantly reduce the overall cost of the program. Specifically, we request comment on the extent to which a difference—or unexpected difference—in the marginal costs of compliance per gallon of fuel saved or ton of GHG reduced across categories or subcategories, combined with provision for averaging and trading across categories and subcategories, can allow manufacturers to achieve the same overall reduction in fuel use and emissions at lower cost.

While trading restrictions in the context of past EPA rulemakings have been motivated in part by the local or regional nature of the pollutant being regulated, in this instance, opportunities for greater flexibility may exist in light of the fact that greenhouse gases are a global pollutant for which local consequences are related to global, not local or regional atmospheric concentrations. However, trading ratios may need to be established for averaging and trading across categories, and potentially across subcategories, to ensure that averaging and trading across categories and subcategories does not lead to a net increase in emissions or fuel use in light of differences in vehicle use patterns across categories and subcategories. Further, it is possible to design trading ratios that ensure a net reduction in emissions and fuel use as a result of averaging and trading. The agencies also request comment on the potential additional savings in costs (beyond those already calculated in this proposal) due to increased flexibility in averaging and trading provisions, on how such averaging and trading flexibilities could be designed to ensure environmental neutrality, on whether trading ratios should be designed to achieve a net reduction in emissions and fuel use as a result of trading, on the concerns that have been raised by some regarding impacts on intra-industry competition, and on how to address the above identified concerns about dissimilarities in operation and use of vehicles.

(1) Heavy-duty Engines

For the heavy-duty engine ABT program, EPA and NHTSA are proposing to use EPA's existing regulatory engine classifications as the subcategory designations under this engine ABT program. The proposed regulations use the term "averaging set" which aligns with the regulatory subcategories or regulatory class in the context that they define the same set of products. The existing diesel engine subcategories are light-heavy-duty (LHD), medium-heavy-duty (MHD), and heavy-heavy-duty (HHD). LHD diesel engines are primarily used in vehicles with a GVWR below 19,500 lb. Vehicle body types in this group might include any heavy-duty vehicle built for a light-duty truck chassis, van trucks, multi-stop vans, recreational vehicles, and some single axle straight trucks. Vehicles containing these engines would normally include personal transportation, light-load commercial hauling and delivery, passenger service, agriculture, and construction applications.

MHD diesel engines are normally used in vehicles whose GVWR varies from 19,501–33,000 lb. Vehicles containing these engines typically include school buses, tandem axle straight trucks, city tractors, and a variety of special purpose vehicles such as small dump trucks, and trash compactor trucks. Normally the applications for these vehicles would include commercial short haul and intra-city delivery and pickup.

HHD diesel engines are intended for use in vehicles which exceed 33,000 lb GVWR. Vehicles containing engines of this type are normally tractors, trucks, and buses used in inter-city, long-haul applications. HHD engines are generally regarded as designed for rebuild and have a long useful life period. LHD and MHD engines are typically not intended for rebuild, though some MHD engines are designed for rebuild, and have a shorter useful life.

Gasoline or spark ignited engines for heavy-duty vehicles fall into one separate regulatory subcategory. These engines are typically installed in trucks with a GVWR ranging from 8,500 pounds to 19,500 pounds although they can be installed into trucks of any size.

The compliance program we are proposing would adopt a slightly different method for generating a manufacturer's CO_2 emission and fuel consumption credit or deficit. The manufacturer's certification test result would serve as the basis for the generation of the manufacturer's Family Certification Level (FCL). The FCL is a new term we propose for this program to differentiate the purpose of this credit generation technique from the Family Emission Limit (FEL) previously used in a similar context in other EPA rules. A manufacturer could define its FCL at any level at or above the certification test result. Credits for the ABT program would be generated when the FCL is compared to its CO_2 and fuel consumption standard, as discussed in Section II. The credits earned in this section would be restricted to the engine subcategory and not tradable with other engine subcategories consistent with EPA's past practice for ABT programs as described previously. Credit calculation for the proposed Engine ABT and program would be generated, either positive or negative, according to Equation IV–1 and Equation IV–2:

Equation IV–1: Proposed HD Engine CO_2 credit (deficit)

$$\text{HD Engine } CO_2 \text{ credit (deficit) (metric tons)} = (\text{Std} - \text{FCL}) \times (\text{CF}) \times (\text{Volume}) \times (\text{UL}) \times (10^{-6})$$

Where:

Std = the standard associated with the specific engine regulatory subcategory (g/bhp-hr)

FCL = Family Certification Level for the engine family

CF = a transient cycle conversion factor in bhp-hr/mile which is the integrated total cycle brake horsepower-hour divided by the equivalent mileage of the Heavy-duty FTP cycle. For gasoline heavy-duty engines, the equivalent mileage is 6.3 miles. For diesel heavy-duty engines, the equivalent mileage is 6.5 miles. The agencies are proposing that the CF determined by the Heavy-duty FTP cycle be used for engines certifying to the SET standard.

Volume = (projected or actual) production volume of the engine family

UL = useful life of the engine (miles)

10^{-6} converts the grams of CO_2 to metric tons

Equation IV–2: Proposed HD Engine Fuel Consumption credit (deficit) in gallons

HD Engine Fuel Consumption credit (deficit) (gallons) = (Std − FCL) × (CF) × (Volume) × (UL) × 10^2

Where:

Std = the standard associated with the specific engine regulatory subcategory (gallon/100 bhp-hr)

FCL = Family Certification Level for the engine family (gallon/100 bhp-hr)

CF = a transient cycle conversion factor in bhp-hr/mile which is the integrated total cycle brake horsepower-hour divided by the equivalent mileage of the Heavy-duty FTP cycle. For gasoline heavy-duty engines, the equivalent mileage is 6.3 miles. For diesel heavy-duty engines, the equivalent mileage is 6.5 miles. The agencies are proposing that the CF determined by the Heavy-duty FTP cycle be used for engines certifying to the SET standard.

Volume = (projected or actual) production volume of the engine family

UL = useful life of the engine (miles)

10^2 = conversion to gallons

To calculate credits or deficits, manufacturers would determine an FCL for each engine family they have designated for the ABT program. We have defined engine families in 40 CFR 1036.230 and manufacturers may designate how to group their engines for certification and compliance purposes. The FCL may be above (negative) or below (positive) its standard and would be used to establish the CO_2 credits earned (or used) in Equation IV–1. The proposed CO_2 and fuel consumption standards are associated with specific regulatory subcategories as described in Sections II.B and II.D (gasoline, light heavy-duty diesel, medium heavy-duty diesel, and heavy heavy-duty diesel). In the ABT program, engines certified with an FCL below the standard generate positive credits (g/bhp-hr and gal/100 bhp-hr). As discussed in Section II.B and II.D, engine families for which a manufacturer elects to use the alternative standard of a percent reduction from the engine family's 2011 MY baseline would be ineligible to either generate or use credits.

The volume used in Equations IV–1 and IV–2 refers to the total number of eligible engines sold per family participating in the ABT program during that model year. The useful life values in Equation IV–1 are proposed to be the same as the regulatory classifications previously used for the engine subcategories. Thus, the agencies propose that for LHD diesel engines and gasoline engines, the useful life values would be 110,000 miles; for MHD diesel engines, 185,000 miles; and for HHD diesel engines, 435,000 miles.

As noted above, credits generated by engine manufacturers under this ABT program would be restricted for use only within their engine subcategory based on performance against the standard as defined in Section II.B and II.D. Thus, LHD diesel engine manufacturers could only use their LHD diesel engine credits for averaging, banking and trading with LHD diesel engines, not with MHD diesel or HHD diesel engines. This limitation is consistent with ABT provisions in EPA's existing criteria pollutant program for engines and would help assure that credits earned to reduce GHG emissions and fuel consumption would be used to limit their growth and not circumvent the intent of the regulations. EPA and NHTSA are concerned that extending the use of credits beyond these designated subcategories could also create an advantage for large or integrated manufacturers that currently does not exist in the market. A manufacturer that produces both engines and heavy-duty highway vehicles could mix credits across engine and vehicle categories, shifting the burden between the sectors, not equally shared in either sector, to gain an advantage over competitors that are not integrated. Similarly, large volume manufacturers of engines can shift credits between heavy heavy-duty diesel engines and light heavy-duty diesel engines to gain an advantage in one subcategory over other manufacturers that may not have multiple engine offerings over several regulatory engine subcategories. Finally, relating credits between subcategories of engines could be problematic because of the differences in regulatory useful lives. The agencies want to avoid having credits from longer useful life categories flooding shorter useful life categories, adversely impacting compliance with the proposed CO_2 and fuel consumption standards in the shorter useful life category. The agencies would like to ensure that this regulation reduces CO_2 emissions and improves fuel consumption in each engine subcategory while not interfering with the ability of manufacturers to engage in free trade and competition. Limiting credit ABT to the regulatory subcategory and not between engines and vehicles would help prevent a competitive advantage due solely to the regulatory structure. Although the reasons for restricting engine credits to the same engine subcategory seem persuasive to us, the agencies welcome comments on the extension of credits beyond the limitations we are proposing.[196]

Under previous ABT programs for other rulemakings, EPA has allowed manufacturers to carry forward deficits from engines for a set period of time. The agencies are proposing to allow manufacturers of engines to carry forward deficits for up to three years before reconciling the short-fall. However, manufacturers would need to use credits, once credits are generated, to offset a shortfall before credits may be banked or traded for additional model years. This restriction reduces the chance of manufacturers passing forward deficits before reconciling shortfalls and exhausting those credits before reconciling past deficits. We will accept comments on alternative approaches for reconciling deficit shortfalls in the engine category.

As described in Section II above, EPA is proposing that a manufacturer may choose to comply with the N_2O or CH_4 cap standards using CO_2 credits. A manufacturer choosing this option would convert its N_2O or CH_4 test results into CO_2eq to determine the amount of CO_2 credits required. This approach recognizes the inter-correlation of these elements in impacting global warming. This option does not apply to the NHTSA fuel consumption program. To account for the different global warming potential of these GHGs, EPA proposes that manufacturers determine the amount of CO_2 credits required by multiplying the shortfall by the GWP. For example, a manufacturer would use 25 kg of positive CO_2 credits to offset 1 kg of negative CH_4 credits. Or a manufacturer would use 298 kg of positive CO_2 credits to offset 1 kg of negative N_2O credits. In general we do not expect manufacturers to use this provision. However, we are providing this alternative as a flexibility in the event an engine manufacturer has trouble meeting the CH_4 and/or N_2O emission caps. There are not ABT credits for performance that falls below the CH_4 or N_2O caps.

Additional flexibilities for engines are discussed later in Section IV(B).

[196] These concerns were not present in the 2012–2016 MY light-duty vehicle rule, where most manufacturers offer diverse product lines and there is not as much disparity among useful lives. That rule consequently does not restrict CO_2 credit trading opportunities between light-duty vehicle sectors.

(2) Class 7 and 8 Combination Tractors

In addition to the engine ABT program described above, the agencies are also proposing a vehicle ABT program to facilitate reductions in GHG emissions and fuel consumption based on combination tractor design changes and improvements. For this category, the structure of the proposed ABT program should create incentives for tractor manufacturers to advance new, clean technologies, or existing technologies earlier than they would otherwise.

As explained in Sections II and III above, combination tractor manufacturers are divided into nine regulatory subcategories under these proposed rules, as shown in the following table:

Table IV-1: Proposed Regulatory Subcategories for Combination Tractors

Class 7 Day Cab	Class 8 Day Cab	Class 8 Sleeper Cab
Low Roof	Low Roof	Low Roof
Mid Roof	Mid Roof	Mid Roof
High Roof	High Roof	High Roof

The proposed regulations use the term "averaging set" which aligns with the regulatory subcategories or regulatory class in the context that they define the same set of products. Vehicle credits for tractors in these classifications would be earned on a g/ton-mile or gallon/1,000 ton-mile basis for tractors which are below the standard. Credits generated within regulatory subcategories would be tradable between truck manufacturers in that specific regulatory subcategory only. Credits would not be fungible between engine and vehicle regulatory categories. This is similar to the restrictions we have described above for engine manufacturers.

This limitation would help ensure that credits earned to reduce GHG emissions and fuel consumption would be used to limit their growth and not circumvent the intent of our regulation. As with engine credits, we are concerned that extending the use of credits to be transferred or traded to other classes may create an advantage for large or integrated manufacturers that currently does not exist in the market. We would like to ensure that this regulation reduces the emission of CO_2 and fuel consumption but does not effectively penalize non-integrated manufacturers and those with limited participation in the market. ABT provides manufacturers the flexibility to deal with unforeseen shifts in the marketplace that affect sales volumes. This structure allows for a straightforward compliance program for each sector independently with aspects that are also independently quantifiable and verifiable. Credit calculation for the proposed Class 7 and 8 tractor CO_2 and fuel consumption credits would be generated, either positive or negative, according to Equation IV–3 and Equation IV–4:

Equation IV–3: The Proposed Class 7 and 8 Tractor CO_2 Credit (Deficit)

Class 7 and 8 Tractor CO_2 credit (deficit)(metric tons) = (Std-FEL) × (Payload Tons) × (Volume) × (UL) × (10^{-6})

Where:

Std = the standard associated with the specific tractor regulatory class (g/ton-mile)

Payload tons = the prescribed payload for each class in tons (12.5 tons for Class 7 and 19 tons for Class 8)

FEL = Family Emission Limit for the tractor family which is equal to the output from GEM (g/ton-mile)

Volume = (projected or actual) production volume of the tractor family

UL = useful life of the tractor (435,000 miles for Class 8 and 185,000 miles for Class 7)

10^{-6} converts the grams of CO_2 to metric tons

Equation IV–4: Proposed Class 7 and 8 Tractor Fuel Consumption credit (deficit) in gallons:

Class 7 and 8 Tractor Fuel Consumption credit (deficit)(gallons) = (Std − FEL) × (Payload Tons) × (Volume) × (UL) × 10^3

Where:

Std = the standard associated with the specific tractor regulatory subcategory (gallons/1,000 ton-mile)

Payload tons = the prescribed payload for each class in tons (12.5 tons for Class 7 and 19 tons for Class 8)

FEL = Family Emission Limit for the tractor family (gallons/1,000 ton-mile)

Volume = (projected or actual) production volume of the tractor family

UL = useful life of the tractor (435,000 miles for Class 8 and 185,000 miles for Class 7)

10^3 = conversion to gallons

Similar to the proposed Heavy-duty Engine ABT program described in the previous section, we are proposing that tractor manufacturers would be able to carry forward credit deficits from their regulatory subcategories for three years before reconciling the shortfall. However, just as in the engine category, manufacturers would need to use credits once those credits have been generated to offset a shortfall before those credits can be banked or traded for additional model years. This restriction reduces the chance of tractor manufacturers passing forward deficits before reconciling their shortfalls and exhausting those credits before reconciling past deficits. Manufacturers of vehicles that generate a deficit at the end of the model year could carry that deficit forward for three years following the model year for which that deficit was generated. Deficits would need to be reconciled at the reporting dates for year three. We will accept comments on alternative approaches of reconciling deficit shortfalls.

Additional flexibilities for Class 7 and 8 combination tractors are discussed later in Section IV.B.

(3) Class 2b–8 Vocational Vehicles

Similar to the Class 7 and 8 combination tractor manufacturers, we are offering a limited ABT program for Class 2b–8 vocational chassis manufacturers. Vehicle credits would be generated for those manufacturers that introduce products into the market with rolling resistance improvements which are better than required to meet the proposed vehicle standards, The certification of the chassis would be based on the use of LRR tires. Credit calculation for the proposed Class 2b–8 vocational vehicle CO_2 and fuel consumption credits (deficits) would be generated, either positive or negative, according to Equation IV–5 and Equation IV–6:

Equation IV–5: The proposed Vocational Vehicle CO_2 vehicle credit (deficit)

Vocational Vehicle CO_2 credit (deficit) (metric tons) = (Std − FEL) ×

(Payload Tons) × (Sales Volume) × (UL) × (10^{-6})

Where:

Std = the standard associated with the specific vocational vehicle subcategory (g/ton-mile)
Payload tons = the prescribed payload for each subcategory in tons (2.85 tons for LHD, 5.6 tons for MHD, and 19 tons for HHD vehicles)
FEL = Family Emission Limit for the vehicle family (g/ton-mile)
Volume = (projected or actual) production volume of the vehicle family
UL = useful life of the vehicle (110,000 miles for LHD, 185,000 miles for MHD, or 435,000 miles for HHD vehicles)
10^{-6} converts the grams of CO_2 to metric tons

Equation IV–6: Proposed Vocational Vehicle Fuel Consumption credit (deficit) in gallons

Vocational Vehicle Fuel Consumption credit for (deficit) (gallons) = (Std − FEL) × (Payload Tons) × (Sales Volume) × (UL) × 10^3

Where:

Std = the standard associated with the specific vocational vehicle regulatory subcategory (gallon/1,000 ton-mile)
Payload tons = the prescribed payload for each regulatory subcategory in tons (2.85 tons for LHD, 5.6 tons for MHD, and 19 tons for HHD vehicles)
FEL = Family Emission Limit for the vehicle family (gallon/1,000 ton-mile)
Volume = (projected or actual) production volume of the vehicle family
UL = useful life of the vehicle (110,000 miles for LHD, 185,000 miles for MHD, or 435,000 miles for HHD vehicles)
10^3 converts to gallons

Also, similar to the proposed heavy-duty engine and tractor ABT programs, the vehicle credits generated within each regulatory subcategory would be allowed to be averaged, banked, or traded between chassis manufacturers within their existing subcategories. For vocational vehicles the proposed vehicle subcategories are based on the vehicle's GVWR. We are proposing three vehicle subcategories LHD with a GVWR less than or equal to 19,500 pounds, MHD vehicles with a GVWR greater than 19,500 and less than or equal to 33,000 pounds, and HHD vehicles with a GVWR greater than 33,000 pounds. These three weight categories would form the subcategories for vocational vehicles and are found in 40 CFR 1037.230. The proposed regulations use the term "averaging set" which aligns with the regulatory categories or regulatory class in the context that they define the same set of products.

Similar to the proposed Heavy-duty Engine ABT program above, vocational chassis manufacturers would be able to carry forward deficits for three years before reconciling the shortfall. However, just as in the engine category, manufacturers would need to use credits earned once those credits have been generated to offset a shortfall before those credits can be banked or traded for additional model years. This restriction reduces the chance of chassis manufacturers passing forward deficits before reconciling their shortfalls and exhausting those credits before reconciling past deficits. Manufacturers of vocational vehicles that generate a deficit at the end of the model year could carry that deficit forward for three years following the model year for which that deficit was generated. Deficits would need to be reconciled at the reporting dates for year three. We will accept comments on alternative approaches of reconciling deficit shortfalls.

(4) Heavy-Duty Pickup Truck and Van Flexibility Provisions

EPA and NHTSA are proposing specific flexibility provisions for manufacturers of HD pickups and vans, similar to provisions adopted in the recent rulemaking for light-duty car and truck GHGs and fuel economy. Additional flexibilities that apply to the broad range of heavy-duty vehicles, including HD pickups and vans, are discussed in Section IV.B. All of these flexibilities would help enable new technologies to be implemented faster and more cost-effectively than without a flexibility program, and also help manufacturers deal with unexpected shifts in sales.

A manufacturer's credit or debit balance would be determined by calculating their fleet average performance and comparing it to the manufacturer's CO_2 and fuel consumption standards, as determined by their fleet mix, for a given model year. A target standard is determined for each vehicle with a unique payload, towing capacity and drive configuration. These unique targets, weighted by their associated production volumes, are summed at the end of the model year to derive the production volume-weighted manufacturer annual fleet average standard. A manufacturer would generate credits if its fleet average CO_2 or fuel consumption level is lower than its standard and would generate debits if its fleet average CO_2 or fuel consumption level is above that standard. The end-of-year reports would provide appropriate data to reconcile pre-compliance estimates with final model year figures. Similar to the light-duty GHG program, the agencies would address any ultimate deficits by a possible void of certificates on a sufficient number of vehicles to address the shortfall. Enforcement action would entail penalty or other relief as appropriate or applicable.

In addition to production weighting, we are proposing that the EPA credit calculations include a factor for the vehicle useful life, in miles, in order to allow the expression of credits in metric tons, as in the light-duty GHG program. The NHTSA credit calculation would use standard and performance levels in fuel consumption units (gallons per 100 miles), as opposed to fuel economy units (mpg) as done in the light-duty program, along with the vehicle useful life, in miles, allowing the expression of credits in gallons. We propose that other provisions for the generation, tracking, trading, and use of the credits be the same as those adopted in the light-duty GHG program, including a 5-year limit on credit carry-forward to future model years and a 3-year limit on deficit carry-forward (or credit carry-back).

The total model year fleet credit (debit) calculations would use the following equations:

CO_2 Credits (Mg) = [(CO_2 Std − CO_2 Act) × Volume × UL] ÷ 1,000,000

Fuel Consumption Credits (gallons) = (FC Std − FC Act) × Volume × UL × 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 class
UL = the useful life for the regulatory class (miles)

We are proposing that HD pickups and vans comprise a self-contained averaging set, such that credits earned may be used freely for other HD pickups and vans but not for other vehicles or engines, and credits generated by other vehicles or engines may not be used to demonstrate compliance for HD pickups and vans. We believe this approach is appropriate because the HD pickup and van fleet is relatively small and the balanced fleetwide averaging concept is critical for obtaining the desired technology development in the 2014–2018 timeframe, so that the potential for large credit flows into or out of this vehicle category would create unwarranted market uncertainty, which in turn could jeopardize the impetus to develop needed technologies. An exception to this approach is proposed for advanced technology credits as discussed in Section IV.B(2).

As described above, HD pickup and van manufacturers would be able to carry forward deficits from their fleet-wide average for three years before reconciling the shortfall. Manufacturers would be required to provide a plan in their pre-model year reports showing how they would resolve projected credit deficits. However, just as in the engine category, manufacturers would need to use credits earned once those credits have been generated to offset a shortfall before those credits can be banked or traded for additional model years. This restriction reduces the chance of vehicle manufacturers passing forward deficits before reconciling their shortfalls and exhausting those credits before reconciling past deficits. We request comments on all aspects of the proposed HD pickup and van credit program.

B. Additional Proposed Flexibility Provisions

The agencies are also proposing provisions to facilitate reductions in GHG emissions and fuel consumption beginning in the 2014 model year. While we view our proposed ABT and flexibility structure as sufficient to encourage reduction efforts by heavy-duty highway engine and vehicle manufacturers, we understand that other efforts may enhance the overall GHG and fuel consumption reduction we anticipate achieving. Therefore we propose the following flexibilities to create additional opportunities for manufacturers to reduce their GHG emissions and fuel consumption. These opportunities would help provide additional incentives for manufacturers to innovate and to develop new strategies and cleaner technologies.

(1) Early Credit Option

The agencies are proposing that manufacturers of HD engines, combination tractors, and vocational vehicles be eligible to generate early credits if they demonstrate improvements in excess of the proposed standards prior to model year they become effective. The start dates for EPA's GHG standards and NHTSA's fuel consumption standards vary by regulatory category (*see* Section II for the model years when the standards become effective). Specifically, manufacturers would need to certify their engines or vehicles to the standards at least six months before the start of the first model year of the mandatory standards. The limitations on the use of credits in the ABT programs—*i.e.*, limiting averaging to within each the regulatory category and vehicle or engine subcategory—would apply for the proposed early credits as well.

NHTSA and EPA also request comment on whether a credit multiplier, specifically a multiplier of 1.5, would be appropriate to apply to early credits from HD engines, combination tractors, and vocational vehicles, as a greater incentive for early compliance. Additionally, the agencies seek comment on whether or not a requirement that HD engines, combination tractors, and vocational vehicles that are eligible to generate early credits, be allowed to do so only if they certify prior to June 1, 2013 should a multiplier of 1.5 be applied to early credits.

We are proposing that manufacturers of HD pickups and vans who demonstrate improvements for model year 2013 such that their fleet average emissions and fuel consumption are lower than the model year 2014 standards be eligible for early credits. Under the proposed structure for the fleet average standards, this credit opportunity would entail certifying a manufacturer's entire HD pickup and van fleet in model year 2013, and assessing this fleet against the model year 2014 target levels discussed in Section II. The agencies consider the proposed availability of early credits to be a valuable complement to the overall program to the extent that they encourage early implementation of effective technologies. We request comment on ways the early credit opportunities can be tailored to accomplish this objective and protect against unanticipated windfalls.

(2) Advanced Technology Credits

EPA and NHTSA are proposing targeted provisions that we expect would promote the implementation of advanced technologies. Specifically, manufacturers that incorporate these technologies would be eligible for special credits that could be applied to other heavy-duty vehicles or engines, including those in other heavy-duty categories. We seek comment on any conversion factors that may be needed. Technologies that we propose to make eligible are:

- Hybrid powertrain designs that include energy storage systems.
- Rankine cycle engines.
- All-electric vehicles.
- Fuel cell vehicles.

NHTSA and EPA request comment on whether a credit multiplier, specifically a multiplier of 1.5, would be appropriate to apply to advanced technology credits, as a greater incentive for their introduction. NHTSA and EPA request comment on the list of technologies identified as advanced technologies and whether additional technologies should be added to the list. NHTSA and EPA also request comment on whether credits generated from vehicles complying prior to 2014 and using Advanced SmartWay or Advanced SmartWay II aerodynamic technologies should be designated as Advanced Technology Credits.

(a) All-Electric Vehicles and HD Pickup Truck and Van Hybrids

For HD pickup and van hybrids, we propose that testing would be done using adjustments to the test procedures developed for light-duty hybrids. NHTSA and EPA are also proposing that all-electric and other zero emission vehicles produced in model years before 2014 be able to earn credits for use in the 2014 and later HD pickup and van compliance program, provided the vehicles are covered by an EPA certificate of conformity for criteria pollutants. These credits would be calculated based on the 2014 diesel standard targets corresponding to the vehicle's work factor, and treated as though they were earned in 2014 for purposes of credit life. Manufacturers would not have to early-certify their entire HD pickup and van fleet in a model year as for other early-complying vehicles. NHTSA and EPA are also proposing that model year 2014 and later EVs and other zero 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. If advanced technology credits generated by pickups and vans are used in another HD vehicle category, these credits would, of course, be subtracted from the manufacturer's pickup and van category credit balance.

In the 2012–2016 MY Light-Duty Vehicle Rule, EPA discussed at length the issue of whether to account for upstream emissions of GHGs in assessing the amount of credit to offer to various types of electric vehicles—that is, GHG emissions associated with generation of the electricity needed to power the electric vehicle. *See* 75 FR 25434–25436. Although acknowledging that such emissions would not be accounted for if electric vehicle GHG emissions are assessed at zero for credit generating purposes, EPA believed that this was the appropriate course in order to provide an incentive for commercialization of this extremely promising technology. At the same time, EPA adopted a cumulative cap whereby upstream emissions would be accounted for if sales of EVs exceeded a given amount.

The agencies believe that these same considerations apply to heavy-duty vehicles. Indeed, the agencies believe that introduction of EVs into the heavy-duty fleet would be less frequent than for light-duty vehicles, so that there is less risk of dilution of the main standards by unexpectedly high introduction of EVs into the heavy-duty fleet and at least an equally compelling reason to provide an incentive for the technology's commercial introduction. Given the unlikelihood of significant penetration of the technology in the model years of these standards, the agencies similarly do not see a need to adopt the type of cumulative caps which would trigger an upstream emission accounting procedure as in the light-duty vehicle rule. The agencies solicit comment on these issues, however.

(b) Vocational Vehicle and Tractor Hybrids

For vocational vehicles or combination tractors incorporating hybrid powertrains, we propose two methods for establishing the number of credits generated, each of which is discussed next. The agencies are not aware of models that have been adequately peer reviewed with data that can assess this technology without the conclusion of a comparison test of the actual physical product.

(i) Chassis Dynamometer Evaluation

For hybrid certification to generate credits we propose to utilize chassis testing as an effective way to compare the CO_2 emissions and fuel consumption performance of conventional and hybrid vehicles. We are proposing that heavy-duty hybrid vehicles be certified using "A to B" vehicle chassis dynamometer testing. This concept allows a hybrid vocational vehicle manufacturer to directly quantify the benefit associated with use of its hybrid system on an application-specific basis. The concept would entail testing the conventional vehicle, identified as "A", using the cycles as defined in Section V. The "B" vehicle would be the hybrid version of vehicle "A". The "B" vehicle would need to be the same exact vehicle model as the "A" vehicle. As an alternative, if no specific "A" vehicle exists for the hybrid vehicle that is the exact vehicle model, the most similar vehicle model would need to be used for testing. We propose to define the "most similar vehicle" as a vehicle with the same footprint, same payload, same testing capacity, the same engine power system, the same intended service class, and the same coefficient of drag.

To determine the benefit associated with the hybrid system for GHG performance, the weighted CO_2 emissions results from the chassis test of each vehicle would define the benefit as described below:

1. (CO_2_A − CO_2_B)/(CO_2_A) = ________ (Improvement Factor)
2. Improvement Factor × GEM CO_2 Result_B = ________ (g/ton mile benefit)

Similarly, the benefit associated with the hybrid system for fuel consumption would be determined from the weighted fuel consumption results from the chassis tests of each vehicle as described below:

3. (Fuel Consumption_A − Fuel Consumption_B)/(Fuel Consumption_A) = ________ (Improvement Factor)
4. Improvement Factor × GEM Fuel Consumption Result_B = ________ (gallon/1,000 ton mile benefit)

The credits for the hybrid vehicle would be calculated as described in the ABT program by Equation IV–5 and Equation IV–6, except that the result from Equation 2 above replaces the (Std-FEL) value. We are proposing that the tons of CO_2 or gallons of fuel credits generated by a hybrid vehicle could flow into any regulatory subcategory.

The agencies are proposing two sets of duty cycles to evaluate the benefit depending on the vehicle application to assess hybrid vehicle performance—without and with PTO systems. The key difference between these two sets of vehicles is that one set (*e.g.*, delivery trucks) does not operate a PTO while the other set (*e.g.*, bucket and refuse trucks) does.

The first set of duty cycles would apply to the hybrid powertrains used to improve the motive performance of the vehicles without a PTO system (such as pickup and delivery trucks). The typical operation of these vehicles is very similar to the overall drive cycles proposed in Section II. Therefore, the agencies are proposing to use the same vehicle drive cycle weightings for testing these vehicles, as shown in Table IV–2.

Table IV-2: Proposed Drive Cycle Weightings for Hybrid Vehicles Without PTO

	Transient	55 mph	65 mph
Vocational Vehicles	42%	21%	37%
Day Cab Tractors	19%	17%	64%
Sleeper Cab Tractors	5%	9%	86%

The second set of duty cycles apply to testing hybrid vehicles used in applications such as utility and refuse trucks tend to have additional benefits associated with use of stored energy, which avoids main engine operation and related CO_2 emissions and fuel consumption during PTO operation. To appropriately address benefits, exercising the conventional and hybrid vehicles using their PTO would help to quantify the benefit to GHG emissions and fuel consumption reductions. The duty cycle proposed to quantify the hybrid CO_2 and fuel consumption impact over this broader set of operation would be the three primary drive cycles plus a PTO duty cycle. Our proposed PTO cycle is based on consideration of using alternate, appropriate duty cycles with Administrator approval in a public process. The PTO duty cycle as proposed takes into account the sales impact and population of utility trucks and refuse haulers. As described in draft RIA Chapter 3, the agencies are proposing to add an additional PTO cycle to measure the improvement achieved for this type of hybrid powertrain application. The proposed weightings for the hybrids with PTO are included in Table IV–3. The agencies welcome comments on the proposed drive cycle weightings and the proposed PTO cycle.

Table IV-3: Proposed Drive Cycle Weightings for Hybrid Vehicles with PTO

	Transient	55 mph	65 mph	PTO
Vocational Vehicles with PTO	30%	15%	27%	28%

(ii) Engine Dynamometer Evaluation

The engine test procedure we are proposing for hybrid evaluation involves exercising the conventional engine and hybrid-engine system based on an engine testing strategy. The basis for the system control volume, which serves to determine the valid test article, would need to be the most accurate representation of real world functionality. An engine test methodology would be considered valid to the extent the test is performed on a test article that does not mischaracterize criteria pollutant performance or actual system performance. Energy inputs should not be based on simulation data which is not an accurate reflection of actual real world operation. It is clearly important to be sure credits are generated based on known physical systems. This includes testing using recovered vehicle kinetic energy. Additionally, the duty cycle over which this engine-hybrid system would be exercised would need to reflect the use of the application, while not promoting a proliferation of duty cycles which prevent a standardized basis for comparing hybrid system performance. The agencies are proposing the use of the Heavy-duty FTP cycle for evaluation of hybrid vehicles, which is the same test cycle proposed for engines used in vocational vehicles. For powerpack testing, which includes the engine and hybrid systems in a pre-transmission format, the engine based testing is applicable for determination of brake-specific emissions benefit versus the engine standard. For post-transmission powertrain systems and vehicles, the comparison evaluation based on the Improvement Factor and the GEM result based on a vehicle drive trace in a powertrain test cell or chassis dynamometer test cell seem to accurately reflect the performance improvements associated with these test configurations. It is important that introduction of clean technology be incentivized without compromising the program intent of real world improvements in GHG and fuel consumption performance. The agencies seek comments on the most appropriate test procedures to accurately reflect the performance improvement associated with hybrid systems tested using these or other protocols.

(3) Innovative Technology Credits

NHTSA and EPA are proposing a credit opportunity intended to apply to new and innovative technologies that reduce fuel consumption and CO_2 emissions, but for which the reduction benefits are not captured over the test procedure used to determine compliance with the standards (*i.e.*, the benefits are "off-cycle"). *See* 75 FR 25438–25440 where EPA adopted a similar credit program for MY 2012–2016 light-duty vehicles. In this case, the 'test procedure' includes not only the Heavy-duty FTP and SET procedures used to measure compliance with the engine standards, but also the GEM. Eligible innovative technologies would be those that are newly introduced in one or more vehicle models or engines, but that are not yet widely implemented in the heavy-duty fleet. This could include known technologies not yet widely utilized in a particular subcategory. Further, any credits for these off-cycle technologies would need to be based on real-world fuel consumption and GHG reductions that can be measured with verifiable test methods and representing driving conditions typical of the vehicle application.

We would not consider technologies to be eligible for these credits if the technology has a significant impact on CO_2 emissions and fuel consumption over the primary test cycles or are the technologies on whose performance the various vehicle and engine standards are premised. However, EPA and NHTSA are aware of some emerging and innovative technologies and concepts in various stages of development with CO_2 emissions and fuel consumption reduction potential that might not be adequately captured on the proposed certification test cycles, and we believe that some of these technologies might merit some additional CO_2 and fuel consumption credit generating potential for the manufacturer. Examples include predictive cruise control, gear-down protection, and active aerodynamic features not exercised in the certification test, such as adjustable ride height for pickup trucks. We believe it would be appropriate to provide an incentive to encourage the introduction of these types of technologies and that a credit mechanism is an effective way to do so. This optional credit opportunity would be available through the 2018 model year reflecting that technologies may be common by then, but the agencies welcome comment on the need to extend beyond model year 2018.

EPA and NHTSA propose that credits generated using innovative technologies be restricted within the subcategory where the credit was generated. The agencies request comments whether credits generated using innovative technologies should be fungible across vehicle and engine categories.

We are proposing that manufacturers quantify CO_2 and fuel consumption reductions associated with the use of the off-cycle technologies such that the credits could be applied based on the proposed metrics (such as g/mile and gal/100 mile for pickup trucks, g/ton-mile and gal/1,000 ton-mile for tractors and vocational vehicles, and g/bhp-hr and gal/100 bhp-hr for engines). Credits would have to be based on real additional reductions of CO_2 emissions and fuel consumption and would need to be quantifiable and verifiable with a repeatable methodology. Such submissions of data should be submitted to EPA and NHTSA, and would be subject to a public evaluation process in which the public would have opportunity for comment. *See* 75 FR 25440. We propose that the technologies upon which the credits are based would be subject to full useful life compliance provisions, as with other emissions controls. Unless the manufacturer can demonstrate that the technology would not be subject to in-use deterioration over the useful life of the vehicle, the manufacturer would have to account for deterioration in the estimation of the credits in order to ensure that the credits are based on real in-use emissions reductions over the life of the vehicle.

In cases where the benefit of a technological approach to reducing CO_2 emissions and fuel consumption cannot be adequately represented using existing test cycles, EPA and NHTSA would review and approve as appropriate test procedures and analytical approaches to estimate the effectiveness of the technology for the purpose of generating credits. The demonstration program should be robust, verifiable, and capable of demonstrating the real-world emissions benefit of the technology with strong statistical significance. *See* 75 FR

25440. For HD pickups and vans, EPA and NHTSA believe that the 5-cycle approach currently used in EPA's fuel economy labeling program for light-duty vehicles may provide a suitable test regimen, provided it can be reliably conducted on the dynamometer and can capture the impact of the off-cycle technology (*see* 71 FR 77872, December 27, 2006). EPA established the 5-cycle test methods to better represent real-world factors impacting fuel economy, including higher speeds and more aggressive driving, colder temperature operation, and the use of air conditioning.

The CO_2 and fuel consumption benefit of some technologies may be able to be demonstrated with a modeling approach. In other cases manufacturers might have to design on-road test programs that are statistically robust and based on real-world driving conditions. Whether the approach involves on-road testing, modeling, or some other analytical approach, the manufacturer would be required to present a proposed methodology to EPA and NHTSA. EPA and NHTSA would approve the methodology and credits only if certain criteria were met. Baseline emissions and control emissions 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. Approval of the approach to determining a CO_2 and fuel consumption benefit would not imply approval of the results of the program or methodology; when the testing, modeling, or analyses are complete the results would likewise be subject to EPA and NHTSA review and approval. The agencies believe that suppliers and vehicle manufacturers could work together to develop testing, modeling, or analytical methods for certain technologies, similar to the SAE approach used for A/C refrigerant leakage scores. As with the similar procedure for alternative off-cycle credits under the 2012–2016 MY light-duty vehicle program, the agencies would include an opportunity for public comment as part of any approval process.

The agencies request comments on the proposed approach for off-cycle emissions credits, including comments on how best to structure the program. EPA and NHTSA particularly request comments on how the case-by-case approach to assessing off-cycle innovative technology credits could best be designed, including ways to ensure the verification of real-world emissions benefits and to ensure transparency in the process of reviewing manufacturers' proposed test methods.

V. NHTSA and EPA Proposed Compliance, Certification, and Enforcement Provisions

A. Overview

(1) Proposed Compliance Approach

This section describes EPA's and NHTSA's proposed program to ensure compliance with EPA's proposed emission standards for CO_2, N_2O, and CH_4 and NHTSA's proposed fuel consumption standards, as described in Section II. To achieve the goals projected in this proposal, it is important for the agencies to have an effective and coordinated compliance program for our respective standards. As is the case with the Light-Duty GHG and CAFE program, the proposed compliance program for heavy-duty vehicles and engines has two central priorities. (1) To address the agencies' respective statutory requirements; and (2) to streamline the compliance process for both manufacturers and the agencies by building on existing practice wherever possible, and by structuring the program such that manufacturers can use a single data set to satisfy the requirements of both agencies. It is also important to consider the provisions of EPA's existing criteria pollutant program in the development of the approach used for heavy-duty certification and compliance. The existing EPA heavy-duty highway engine emissions program has an established infrastructure and methodology that would allow effective integration with this proposed GHG and fuel consumption program, without needing to create new unique processes in many instances. The compliance program would also need to address the importance of the impact of new control methods for heavy-duty vehicles as well as other control systems and strategies that may extend beyond the traditional purview of the criteria pollutant program.

The proposed heavy-duty compliance program would use a variety of mechanisms to conduct compliance assessments, including preproduction certification and postproduction, in-use monitoring once vehicles enter customer service. Specifically, the agencies are establishing a compliance program that utilizes existing EPA testing protocols and certification procedures. Under the provisions of this program, manufacturers would have significant opportunity to exercise implementation flexibility, based on the program schedule and design, as well as the credit provisions that are being proposed in the program for advanced technologies. This proposal includes a process to foster the use of innovative technologies, not yet contemplated in the current certification process. EPA would continue to conduct compliance preview meetings which provide the agency an opportunity to review a manufacturer's new product plans and ABT projections. Given the nature of the proposed compliance program which would involve both engine and vehicle compliance for some categories, it would be necessary for manufacturers to begin pre-certification meetings with EPA early enough to address issues of certification and compliance for both integrated and non-integrated product offerings.

Based on feedback EPA and NHTSA received during the Light-Duty GHG comment period, both agencies would seek to ensure transparency in the compliance process. In addition to providing information in published reports annually regarding the status of credit balances and compliance on an industry basis, EPA and NHTSA seek comment on additional strategies for providing information useful to the public regarding industry's progress toward reducing GHG emissions and fuel consumption from this sector while protecting sensitive business information.

(a) Heavy-Duty Pickup Trucks and Vans

The proposed compliance regulations (for certification, testing, reporting, and associated compliance activities) for heavy-duty pickup trucks and vans closely track both current practices and the recently adopted greenhouse gas regulations for light-duty vehicles and trucks. Thus they would be familiar to manufacturers. EPA already oversees testing, collects and processes test data, and performs calculations to determine compliance with both CAFE and CAA standards for Light-Duty. For Heavy-Duty products that closely parallel light-duty pick-ups and vans, under a coordinated approach, the compliance mechanisms for both programs for NHTSA and EPA would be consistent and non-duplicative for GHG pollutant standards and fuel consumption requirements. Vehicle emission standards established under the CAA apply throughout a vehicle's full useful life.

Under EPA existing criteria pollutant emission standard program for heavy-duty pickup trucks and vans, vehicle manufacturers certify a group of vehicles called a test group. A test group typically includes multiple vehicle lines and model types that share critical emissions-related features. The manufacturer generally selects and tests a single vehicle, typically considered "worst case" for criteria pollutant emissions, which is allowed to represent the entire test group for certification purposes. The test vehicle is the one expected to be the worst case for the emission standard at issue. Emissions from the test vehicle are assigned as the value for the entire test group. However, the compliance program in the recent GHG regulations for light-duty vehicles, which is essentially the well established CAFE compliance program, allows and may require manufacturers to perform additional testing at finer levels of vehicle models and configurations in order to get more precise model-level fuel economy and CO_2 emission levels. This same approach would be applied to heavy-duty pickups and vans. Additionally, like the light-duty program, approved use of analytically derived fuel economy would be allowed to predict the fuel efficiency and CO_2 levels of some vehicles in lieu of testing when deemed appropriate by the agencies. The degree to which analytically derived fuel economy would be allowed and the design of the adjustment factors would be determined by the agencies.

(b) Heavy-Duty Engines

Heavy-duty engine certification and compliance for traditional criteria pollutants has been established by EPA in its current general form since 1985. In developing a program to address GHG pollutants, it is important to build upon the infrastructure for certification and compliance that exists today. At the same time, it is necessary to develop additional tools to address compliance with GHG emissions requirements, since the proposed standard reflect control strategies that extend beyond those of traditional criteria pollutants. In so doing, the agencies are proposing use of EPA's current engine test based strategy—currently used for criteria pollutant compliance—to also measure compliance for GHG emissions. The agencies are also proposing to add new strategies to address vehicle specific designs and hardware which impact GHG emissions. The traditional engine approach would largely match the existing criteria pollutant control strategy. This would allow the basic tools for certification and compliance, which have already been developed and implemented, to be expanded for carbon dioxide, methane, and nitrous oxide. Engines with similar emissions control technology may be certified in engine families, as with criteria pollutants.

For EPA, the proposed approach for certification would follow the current process, which would require manufacturer submission of certification applications, approval of the application, and receipt of the certificate of conformity prior to introduction into commerce of any engines. EPA proposes the certificate of conformity be a single document that would be applicable for both criteria pollutants and greenhouse gas pollutants. NHTSA would assess compliance with its fuel consumption standards based on the results of the EPA GHG emissions compliance process for each engine family.

(c) Class 7 and 8 Combination Tractors and Class 2b–8 Vocational Vehicles

Currently, except for HD pickups and vans, EPA does not directly regulate exhaust emissions from heavy-duty vehicles as a complete entity. Instead, a compliance assessment of the engine is undertaken as described above. Vehicle manufacturers installing certified engines are required to do so in a manner that maintains all functionality of the emission control system. While no process exists for certifying these heavy-duty vehicles, the agencies believe that a process similar to the one we propose for use for heavy-duty engines can be applied to the vehicles.

The agencies are proposing related certification programs for heavy-duty vehicles. Manufacturers would divide their vehicles into families and submit applications to each agency for certification for each family. However, the demonstration of compliance would not require emission testing of the complete vehicle, but would instead involve a computer simulation model, GEM. This modeling tool uses a combination of manufacturer-specified and agency-defined vehicle parameters to estimate vehicle emissions and fuel consumption. This model would then be exercised over certain drive cycles. EPA and NHTSA are proposing the duty cycles over which Class 7 and 8 combination tractors would be exercised to be: 65 mile per hour steady state cruise cycle, the 55 mile per hour steady state cruise cycle, and the California ARB transient cycle. Additional details regarding these duty cycles will be addressed in Section V.D(1)(b) below. Over each duty cycle, the simulation tool would return the expected CO_2 emissions, in g/ton-mile, and fuel consumption, gal/1,000 ton-mile, which would then be compared to the standards.

B. Heavy-Duty Pickup Trucks and Vans

(1) Proposed Compliance Approach

EPA and NHTSA are proposing new emission standards to control greenhouse gases (GHGs) and reduce fuel consumption from heavy-duty trucks between a gross vehicle weight rating between 8,500 and 14,000 pounds that are not already covered under the MY 2012–2016 light-duty truck and medium-duty passenger vehicle GHG standards. In this section "trucks" now refers to heavy-duty pickup trucks and vans between 8,500 and 14,000 pounds not already covered under the above light-duty rule.

First, EPA is proposing fleet average emission standards for CO_2 on a gram per mile (g/mile) basis and NHTSA is proposing fuel consumption standards on a gal/100 mile basis that would apply to a manufacturer's fleet of heavy-duty trucks and vans with a GVWR from 8,500 pounds to 14,000 pounds (Class 2b and 3). CO_2 is the primary pollutant resulting from the combustion of vehicular fuels, and the amount of CO_2 emitted is highly correlated to the amount of fuel consumed. In addition, the EPA is proposing separate emissions standards for three other GHG pollutants: CH_4, N_2O, and HFC. CH_4 and N_2O emissions relate closely to the design and efficient use of emission control hardware (*i.e.*, catalytic converters). The standards for CH_4 and N_2O would be set as caps that would limit emissions increases and prevent backsliding from current emission levels. In lieu of meeting the caps, EPA is optionally proposing that manufacturer could offset any N_2O emissions or any CH_4 emissions above the cap by taking steps to further reduce CO_2. Separately, EPA is proposing to set standards to control the leakage of HFCs from air conditioning systems. EPA and NHTSA are requesting comment on the opportunity for manufacturers to earn credits toward the fleet-wide average CO_2 and fuel consumption standards for improvements to air conditioning system efficiency that reduce the load on the engine and thereby reduce CO_2 emissions and fuel consumption.

Previously, complete vehicles with a Gross Vehicle Weight Rating of 8,500–14,000 pounds could be certified according to 40 CFR part 86, subpart S. These heavy-duty chassis certified vehicles were required to pass emissions on both the Light-duty FTP and HFET (California certified only requirement).[197] These proposed rules would use the same testing procedures already required for heavy-duty chassis certification, namely the Light-duty FTP and the HFET but extend the requirement for chassis certification for CO_2 emissions to diesel-powered vehicles. Currently, chassis certification is a gasoline requirement and a diesel option. Using the data from these two tests, EPA and NHTSA would compare the CO_2 emissions and fuel consumption results against the attribute-based target. The attribute upon which the CO_2 standard would be based would be a function of vehicle payload, vehicle towing capacity and two-wheel versus four-wheel drive configuration as discussed in Section II.C(1)(b) of this notice. The attribute-based standard targets would be used to determine a manufacturer fleet standard and would be subject to an average banking and trading scheme similar to the light-duty GHG rule.

This proposal would require nearly all heavy-duty trucks between 8,500 and 14,000 pounds gross vehicle weight rating that are not already covered under the light-duty truck and medium-duty passenger vehicle GHG standards to have a CO_2, CH_4 and N_2O values assigned to them, either from actual chassis dynamometer testing or from the results of a representative vehicle in the test group with appropriate adjustments made for differences. This requirement would apply based on whether the vehicle manufacturer sold the vehicle as a complete or nearly complete vehicle.[198] Manufacturers would be allowed to exclude vehicles they sell to secondary manufacturers without cabs (often known as rolling chassis), as well as a very small number of vehicles sold with cabs. Specifically, a manufacturer could certify up to two percent of its vehicles with complete cabs, or up to 2,000 vehicles if its total sales in this category was less than 100,000, as vocational vehicles. To the extent manufacturers are allowed to engine certify for criteria pollutant (non-GHG) requirements today, they would be allowed to continue to do so under the proposed regulations.

Because the program being proposed for heavy-duty pickup trucks and vans is so similar to the program recently adopted for light-duty trucks and codified in 40 CFR part 86, subpart S, EPA is proposing to apply most of those subpart S regulatory provisions to heavy-duty pickup trucks and vans and to not recodify them in the new part 1037. Most of the new part 1037 would not apply for heavy-duty pickup trucks and vans. How 40 CFR part 86 applies, and which provisions of the new 40 CFR part 1037 apply for heavy-duty pickup trucks and vans is described in § 1037.104.

(a) Certification Process

CAA section 203(a)(1) prohibits manufacturers from introducing a new motor vehicle into commerce unless the vehicle is covered by an EPA-issued certificate of conformity. Section 206(a)(1) of the CAA describes the requirements for EPA issuance of a certificate of conformity, based on a demonstration of compliance with the emission standards established by EPA under section 202 of the Act. The certification demonstration requires emission testing, and must be done for each model year.[199]

Under existing heavy-duty chassis certification and other EPA emission standard programs, vehicle manufacturers certify a group of vehicles called a test group. A test group typically includes multiple vehicle car lines and model types that share critical emissions-related features.[200] The manufacturer generally selects and tests one vehicle to represent the entire test group for certification purposes. The test vehicle is the one expected to be the worst case for the criteria emission standard at issue.

EPA requires the manufacturer to make a good faith demonstration in the certification application that vehicles in the test group will both (1) comply throughout their useful life within the emissions bin assigned, and (2) contribute to fleetwide compliance with the applicable emissions standards when the year is over. EPA issues a certificate for the vehicles included in the test group based on this demonstration, and includes 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 with the applicable standards.

The certification process often occurs several months prior to production and manufacturer testing may occur months before the certificate is issued. The certification process for the existing heavy-duty chassis program is an efficient way for manufacturers to conduct the needed testing well in advance of certification, and to receive certificates in a time frame which allows for the orderly production of vehicles. The use of conditions on the certificate has been an effective way to ensure that manufacturers comply throughout their useful life and meet fleet standards when the model year is complete and the accounting for the individual model sales is performed. EPA has also adopted this approach as part of its LD GHG compliance program.

EPA is proposing to similarly condition each certificate of conformity for the GHG program upon a manufacturer's good faith demonstration of compliance with the manufacturer's fleetwide average CO_2 standard. The following discussion explains how EPA proposes to integrate the proposed vehicle certification program into the existing certification program.

An integrated approach with NHTSA will be undertaken to allow manufacturers a single point of entry to address certification and compliance. Vehicle manufacturers would initiate the formal certification process with their submission of application for a certificate of conformity to EPA.

(b) Certification Test Groups and Test Vehicle Selection

For heavy-duty chassis certification to the criteria emission standards, manufacturers currently as mentioned above divide their fleet into "test groups" for certification purposes. The test group is EPA's unit of certification; one certificate is issued per test group. These groupings cover vehicles with similar emission control system designs expected to have similar emissions performance (*see* 40 CFR 86.1827–01). The factors considered for determining test groups include Gross Vehicle Weight, combustion cycle, engine type, engine displacement, number of cylinders and cylinder arrangement, fuel type, fuel metering system, catalyst construction and precious metal composition, among others. Vehicles having these features in common are generally placed in the same test group.[201]

EPA is proposing to retain the current test group structure for heavy-duty pickups and vans in the certification requirements for CO_2. At the time of

[197] Diesel engines are engine-certified with the option to chassis certification Federally and for California.

[198] The proposed regulations would use the term "cab-complete vehicle" to refer to incomplete vehicles sold with complete cabs, but lacking a cargo carrying container.

[199] CAA Section 206(a)(1).

[200] The specific test group criteria are described in 40 CFR 86.1827–01, car lines and model types have the meaning given in 40 CFR 86.1803–01.

[201] EPA provides for other groupings in certain circumstances, and can establish its own test groups in cases where the criteria do not apply. *See* 40 CFR 86.1827–01(b), (c) and (d).

certification, manufacturers would use the CO_2 emission level from the Emission Data Vehicle as a surrogate to represent all of the models in the test group. However, following certification further testing would generally be allowed for compliance with the fleet average CO_2 standard as described below. EPA's issuance of a certificate would be conditioned upon the manufacturer's subsequent model level testing and attainment of the actual fleet average, much like light-duty CAFE and GHG compliance requires. Under the current program, complete heavy-duty Otto-cycle vehicles under 14,000 pounds Gross Vehicle Weight Rating are required to chassis certify (*see* 40 CFR 86.1801–01(a)). The current program allows complete heavy-duty diesel vehicles under 14,000 pounds GVWR to optionally chassis certify (*see* 40 CFR 86.1863–07(a)). As discussed earlier, these proposed rules would now require all HD vehicles under 14,000 pounds GVWR to chassis certify except as noted in Section II.

EPA recognizes that the existing heavy-duty chassis test group criteria do not necessarily relate to CO_2 emission levels. *See* 75 FR 25472. For instance, while some of the criteria, such as combustion cycle, engine type and displacement, and fuel metering, may have a relationship to CO_2 emissions, others, such as those pertaining to the some exhaust aftertreatment features, may not. In fact, there are many vehicle design factors that impact CO_2 generation and emissions but are not major factors included in EPA's test group criteria.[202] Most important among these may be vehicle weight, horsepower, aerodynamics, vehicle size, and performance features. To remedy this, EPA is considering allowing manufacturers provisions similar to the LD GHG rule that would yield more accurate CO_2 estimates than only using the test group emission data vehicle CO_2 emissions.

EPA believes that the current test group concept is appropriate for N_2O and CH_4 because the technologies that would be employed to control N_2O and CH_4 emissions may generally be the same as those used to control the criteria pollutants. However, manufacturers would determine if this approach is adequate method for N_2O and CH_4 emissions compliance or if testing on additional vehicles is required to ensure the entire fleet meet applicable standards.

[202] EPA noted this potential lack of connection between fuel economy testing and testing for emissions standard purposes when it first adopted fuel economy test procedures. *See* 41 FR 38677, Sept. 10, 1976.

As just discussed, the "worst case" vehicle a manufacturer selects as the Emissions Data Vehicle to represent a test group under the existing regulations (40 CFR 86.1828–01) may not have the highest levels of CO_2 in that group. For instance, there may be a heavier, more powerful configuration that would have higher CO_2, but may, due to the way the catalytic converter has been matched to the engine, actually have lower NO_X, CO, PM or HC emissions. Therefore, EPA is proposing to require a single Emission Data Vehicle that would represent the test group for both criteria pollutant and CO_2 certification. The manufacturer would be allowed to initially apply the Emission Data Vehicle's CO_2 emissions value to all models in the test group, even if other models in the test group are expected to have higher CO_2 emissions. However, as a condition of the certificate, this surrogate CO_2 emissions value would generally be replaced with actual, model-level CO_2 values based on results from additional testing that occurs later in the model year much like the light-duty CAFE program, or through the use of approved methods for analytically derived fuel economy. This model level data would become the official certification test results (as per the conditioned certificate) and would be used to determine compliance with the fleet average. Only if the test vehicle is in fact the worst case CO_2 vehicle for the test group could the manufacturer elect to apply the Emission Data Vehicle emission levels to all models in the test group for purposes of calculating fleet average emissions. Manufacturers would be unlikely to make this choice, because doing so would ignore the emissions performance of vehicle models in their fleet with lower CO_2 emissions and would unnecessarily inflate their CO_2 fleet average. Testing at the model level would necessarily increase testing burden beyond the minimum Emission Data Vehicle testing.

EPA requests comment regarding whether the existing heavy-duty chassis test group can adequately represent CO_2 emissions for certification purposes, and whether the Emission Data Vehicle's CO_2 emission level is an appropriate surrogate for all vehicles in a test group at the time of certification, given that the certificate would be conditioned upon additional model level testing occurring during the year and that the surrogate CO_2 emission values would be replaced with model-level emissions data from those tests. Comments should also address EPA's desire to minimize the up-front pre-production testing burden and whether the proposed efficiencies would be balanced by the requirement to test all model types in the fleet by the conclusion of the model year in order to establish the fleet average CO_2 levels.

As explained in Sections II and III, there are two standards that the manufacturer would be subject to, the fleet average standard and the in-use standard for the useful life of the vehicle. Compliance with the fleet average standard is based on production weighted averaging of the test data that applies for each model, For each model, the in-use standard is set at 10 percent higher than the level used for that model in calculating the fleet average. The certificate covers both of these standards, and the manufacturer has to demonstrate compliance with both of these standards for purposes of receiving a certificate of conformity. The certification process for the in-use standard is discussed above.

(c) Pre-Model Year (or Compliance Plan) Reporting

EPA and NHTSA are proposing that manufacturers submit a compliance plan for their entire fleet prior to the certification of any test group in a given model year. Preferably, this compliance plan would be submitted at the manufacturer's annual certification preview meeting. This preview meeting is typically held before the earliest date that the model year can begin. The earliest a model year can begin is January 2nd of the calendar year prior to the model year. This plan would include the manufacturer's estimate of its attribute-based standard, along with a demonstration of compliance with the standard based on projected model-level CO_2 emissions and fuel consumption, and production estimates. This information would be similar to the information submitted to NHTSA and EPA in the pre-model year report required for CAFE compliance for light-duty vehicles. Included in the compliance plan, manufacturers seeking to take advantage of credit flexibilities would include these in their compliance demonstration. Similarly, the compliance demonstration would need to include a credible plan for addressing deficits accrued in prior model years. EPA and NHTSA would review the compliance plan for technical viability and conduct a certification preview discussion with the manufacturer. The agencies would view the compliance plan as part of the manufacturer's good faith demonstration, but understands that initial projections can vary considerably from the reality of final production and emission results. In addition, the compliance plan must be approved by the EPA Administrator prior to any certificate of compliance being issued. The agencies request comment on the proposal to evaluate manufacturer compliance plans prior to the beginning of model year certification.

(d) Demonstrating Compliance With the Proposed Standards

(i) CO_2 and Fuel Consumption Fleet Standards

As noted, attribute-based CO_2 standards result in each manufacturer having a fleet average CO_2 standard unique to its heavy-duty truck fleet of GVWR between 8,500–14,000 pounds and that standard would be separate from the standard for passenger cars, light-trucks, and other heavy-duty trucks. The standards depend on those attributes corresponding to the relative capability, or "work factor", of the vehicle models produced by that manufacturer. The proposed attributes used to determine the stringency of the CO_2 standard are payload and towing capacity as described in Section II.C of this notice. Generally, fleets with a mix of vehicles with increased payloads or greater towing capacity (or utilizing four wheel drive configurations) would face numerically less stringent standards (*i.e.,* higher CO_2 grams/mile standards) than fleets consisting of less powerful vehicles. (However, the standards would be expected to be equally challenging and achieve similar percent reductions.) Although a manufacturer's fleet average standard could be estimated throughout the model year based on projected production volume of its vehicle fleet, the final compliance values would be based on the final model year production figures. A manufacturer's calculation of fleet average emissions at the end of the model year would be based on the production-weighted average emissions of each model in its fleet. The payload and towing capacity inputs used to determine manufacturer compliance with these proposed rules would be the advertised values.

The agencies propose to use the same general vehicle category definitions that are used in the current EPA HD chassis certification (*See* 40 CFR 86.1816–05). The new vehicle category definitions differ slightly from the EPA definitions for Heavy-duty Vehicle definitions for the existing program, as well as other EPA vehicle programs. Mainly, manufacturers would be able to test, and possibly model, more configurations of vehicles than were historically in a given test group. The existing criteria pollutant program requires the worst case configuration be tested for emissions certification. For HD chassis certification, this usually meant only testing the vehicle with the highest ALVW, road-load, and engine displacement within a given test group. This worst case configuration may only represent a small fraction of the test group production volume. By testing the worst case, albeit possibly small volume, vehicle configuration, the EPA had a reasonable expectation that all represented vehicles would pass the given emissions standards. Since CO_2 standards are a fleet standard based on a combination of sales volume and work factor (*i.e.,* payload and towing capability), it may be in a manufacturer's best interest to test multiple configurations within a given test group to more accurately estimate the fleet average CO_2 emission levels and not accept the worst case vehicle test results as representative of all models. Additionally, vehicle models for which a manufacturer desires to use analytically derived fuel economy (ADFE) to estimate CO_2 emission levels may need additional actual test data for vehicle models of similar but not identical configurations. The agencies are requesting comment on allowing the manufacturer to test as many configurations within a test group as the manufacturer requires in order to best represent the volumes of each configuration within that test group. The agencies are also requesting comment on using an ADFE approach similar to that used by light-duty vehicles, as explained in the light-duty vehicle/light-duty truck EPA guidance document CCD–04–06 titled "Updated Analytically Derived Fuel Economy (ADFE) Policy for 2005 MY and Later", but expanded to a greater fraction of possible subconfigurations and using lower confidence limits than used for light-duty vehicles and light-duty trucks.

The agencies are proposing the use of ADFE similar to that allowed for light-duty vehicles in 40 CFR 600.006–08(e). This provision would allow EPA and NHTSA to accept analytical expressions to generate CO_2 and fuel economy that have been approved in advance by the agencies.

For model years 2014 through 2017, or earlier if a manufacturer is certifying in order to generate early credits, EPA is proposing the equation and parameter values as expressed in Section II C or assigning a CO_2 level to an individual vehicle's relevant attributes. These CO_2 values would be production weighted to determine each manufacturer's fleet average. Each parameter would change on an annual basis, resulting in the annual increase in stringency. For the function used to describe the proposed standard, see Section II.C of this notice.

The GHG and fuel economy rulemaking for light-duty vehicles adopted a carbon balance methodology used historically to determine fuel consumption for the light-duty labeling and CAFE programs, whereby the carbon-related combustion products HC and CO are included on an adjusted basis in the compliance calculations, along with CO_2. The resulting carbon-related exhaust emissions (CREE) of each test vehicle is calculated and it is this value, rather than simply CO_2 emissions, that is used in compliance determinations. The difference between the CREE and CO_2 is typically very small.

NHTSA and EPA are not proposing to adopt the CREE methodology for HD pickups and vans, and so are not proposing to adjust CO_2 emissions to further account for additional HC and CO. The basis of the CREE methodology in historical labeling and CAFE programs is not relevant to HD pickups and vans, because these historical programs do not exist for HD vehicles. Furthermore, test data used in this proposal for standards-setting has not been adjusted for this effect, and so it would create an inconsistency, albeit a small one, to apply it for compliance with the numerical standards we are proposing. Finally, it would add complexity to the program with little real world benefit. We request comment on this proposed approach.

(ii) CO_2 In-Use Standards and Testing

Section 202(a)(1) of the CAA requires emission standards to apply to vehicles throughout their statutory useful life. Section II.B(3)(b) of this proposal discusses in-use standards.

Currently, EPA regulations require manufacturers to conduct in-use testing as a condition of certification for heavy-duty trucks between 8,500 and 14,000 gross vehicle weight that are chassis certified. The vehicles are tested to determine the in-use levels of criteria pollutants when they are in their first and third years of service. This testing is referred to as the In-Use Verification Program, which was first implemented as part of EPA's CAP 2000 certification program (*see* 64 FR 23906, May 4, 1999).

EPA is requesting comment on applying the in-use program already set forth in the 2012–2016 MY light-duty vehicle rule to heavy-duty pickups and vans. The In-Use Verification Program for heavy-duty pickups and vans would follow the same general provisions of the light-duty program in regard to testing, vehicle selection, and reporting. *See* 75 FR 25474–25476.

(e) Cab-Chassis Vehicles and Complete Class 4 Vehicles

As discussed in Section I.C(2)(a), we are proposing to include most cab-chassis Class 2b and 3 vehicles in the complete HD pickup and van program. Because their numbers are relatively small, and to reduce the testing and compliance tracking burden to manufacturers, we would treat these vehicles as equivalent to the complete van or truck product they are derived from. The manufacturer would determine which complete vehicle configuration it produces most closely matches the cab-chassis product leaving its facility, and would include each of these cab-chassis vehicles in the fleet averaging calculations as though it were identical to the corresponding complete vehicle.

Any in-use testing of these vehicles would do likewise, with loading of the tested vehicle to a total weight equal to the ALVW of the corresponding complete vehicle configuration. If the secondary manufacturer had altered or replaced any vehicle components in a way that would substantially affect CO_2 emissions from the tested vehicle (*e.g.,* axle ratio has been changed for a special purpose vehicle), the vehicle manufacturer could request that EPA not test the vehicle or invalidate a test result. Secondary (finisher) manufacturers would not be subject to requirements under this provision, other than to comply with anti-tampering regulations. However, if they modify vehicle components in such a way that GHG emissions and fuel consumption are substantially affected, they become manufacturers subject to the standards under this proposal.

We realize that this approach does not capture the likely loss of aerodynamic efficiency involved in converting these vehicles from standard pickup trucks or vans to ambulances and the like, and thus it could assign them lower GHG emissions and fuel consumption than they deserve. However, we feel that this approach strikes a fair balance between the alternatives—grouping these vehicles with vocational vehicles subject only to engine standards and tire requirements, or creating a complex and burdensome program that forces vehicle manufacturers to track, and perhaps control, a plethora of vehicle configurations they currently do not manage. We request comment on this proposed provision and any suggestions for ways to improve it.

Some complete Class 4 trucks are very similar to complete Class 3 pickup truck models, including their overall vehicle architecture and use of the same basic engines. EPA and NHTSA request comment on whether these vehicles should be regulated as part of the HD pickup and van category and thereby be subject to that regulatory regime (i.e., standard stringency, chassis-based compliance for entire vehicle, credit opportunities limited to HD pickup and van subcategory, etc.), instead of as vocational vehicles as currently proposed. Comment is also requested on whether such chassis certification should be allowed as a manufacturer's option instead, and on whether vehicles so certified for GHG emissions and fuel consumption should also be allowed to certify to chassis-based criteria pollutant standards as well. Commenters are asked to address the environmental impacts of this potential change.

(2) Proposed Labeling Provisions

HD pickups and vans currently have vehicle emission control information labels showing compliance with criteria pollutant standards, similar to emission control information labels for engines. As with engines, we believe this label is sufficient.

(3) Other Certification Issues

(a) Carryover Certification Test Data

EPA's proposed certification program for vehicles allows manufacturers to carry certification test data over from one model year to the next, when no significant changes to models are made. EPA will also apply this policy to CO_2, N_2O and CH_4 certification test data.

(b) Compliance Fees

The CAA allows EPA to collect fees to cover the costs of issuing certificates of conformity for the classes of vehicles and engines covered by this proposal. On May 11, 2004, EPA updated its fees regulation based on a study of the costs associated with its motor vehicle and engine compliance program (69 FR 51402). At the time that cost study was conducted the current rulemaking was not considered.

At this time the extent of any added costs to EPA as a result of this proposal is not known. EPA will assess its compliance testing and other activities associated with the rule and may amend its fees regulations in the future to include any warranted new costs.

C. Heavy-Duty Engines

(1) Proposed Compliance Approach

Section 203 of the CAA requires that all motor vehicles and engines sold in the United States to carry a certificate of conformity issued by the U.S. EPA. For heavy-duty engines, the certificate specifies that the engine meets all requirements as set forth in the regulations (40 CFR part 86, subpart N, for criteria pollutants) including the requirement that the engine be compliant with emission standards. This demonstration is completed through emission testing as well as durability testing to determine the level of emissions deterioration throughout the useful life of the engine. In addition to compliance with emission standards, manufacturers are also required to warrant their products against emission defects, and demonstrate that a service network is in place to correct any such conditions. The engine manufacturer also bears responsibility in the event that an emission-related recall is necessary. Finally, the engine manufacturer is responsible for tracking and ensuring correct installation of any emission related components installed by a second party (*i.e.,* vehicle manufacturer). EPA believes this compliance structure is also valid for administering the proposed GHG regulations for heavy-duty engines.

(a) Certification Process

In order to obtain a certificate of conformity, engine manufacturers must complete a compliance demonstration, normally consisting of test data from relatively new (low-hour) engines as well as supporting documentation, showing that their product meets emission standards and other regulatory requirements. To account for aging effects, low-hour test results are coupled with testing-based deterioration factors (DFs), which provide a ratio (or offset) of end-of-life emissions to low-hour emissions for each pollutant being measured. These factors are then applied to all subsequent low-hour test data points to predict the emissions behavior at the end of the useful life.

For purposes of this compliance demonstration and certification, engines with similar engine hardware and emission characteristics throughout their useful life may be grouped together in engine families, consistent with current criteria-pollutant certification procedures. Examples of such characteristics are the combustion cycle, aspiration method, and aftertreatment system. Under this system, the worst-case engine ("parent rating") is selected based on having the highest fuel feed per engine stroke, and all emissions testing is completed on this model. All other models within the family ("child ratings") are expected to have emissions at or below the parent model and therefore in compliance with emission standards. Any engine within the family can be subject to selective enforcement audits, in-use, confirmatory, or other compliance testing.

We are proposing to continue to use this approach for the selection of the worst-case engine ("parent rating") for fuel consumption and GHG emissions as well. We believe this is appropriate because this worst case engine configuration would be expected to have the highest in-use fuel consumption and GHG emissions within the family. We note that lower engine ratings contained within this family would be expected to have a higher fuel consumption rate when measured over the Federal Test Procedures as expressed in terms of fuel consumption per brake horsepower hour. This higher fuel consumption rate is misleading in the context of comparing engines within a single engine family. This seeming contradiction can be most easily understood in terms of an example. For a typical engine family a top rating could be 500 horsepower with a number of lower engine ratings down to 400 horsepower or lower included within the family. When installed in identical trucks the 400 and 500 horsepower engines would be expected to operate identically when the demanded power from the engines is 400 horsepower or less. So in the case where in-use driving never included acceleration rates leading to horsepower demand greater than 400 horsepower, the two trucks with the 400 and 500 horsepower engines would give identical fuel consumption and GHG performance. When the desired vehicle acceleration rates were high enough to require more than 400 horsepower, the 500 horsepower truck would accelerate faster than the 400 horsepower truck resulting in higher average speeds and higher fuel consumption and GHG emissions measured on a per mile or per ton-mile basis. Hence, the higher rated engine family would be expected to have the highest in-use fuel consumption and CO_2 emissions.

The reason that the lower engine ratings appear to have worse fuel consumption relates to our use of a brake specific work metric. The brake specific metric measures power produced from the engine and delivered to the vehicle ignoring the parasitic work internal to the engine to overcome friction and air pumping work within the engine. The fuel consumed and GHG emissions produced to overcome this internal work and to produce useful (brake) work are both measured in the test cycle but only the brake work is reflected in the calculation of the fuel consumption rate. This is desirable in the context of reducing fuel consumption as this approach rewards engine designs that minimize this internal work through better engine designs. The less work that is needed internal to the engine, the lower the fuel consumption will be. If we included the parasitic work in the calculation of the rate, we would provide no incentive to reduce internal friction and pumping losses. However, when comparing two engines within the very same family with identical internal work characteristics, this approach gives a misleading comparison between two engines as described above. This is the case because both engines have an identical fuel consumption rate to overcome internal work but different rates of brake work with the higher horsepower rating having more brake work because the test cycle is normalized to 100 percent of the engine's rated power. The fuel consumed for internal work can be thought of as a fixed offset identical between both engines. When this fixed offset is added to the fuel consumed for useful (brake) work over the cycle, it increases the overall fuel consumption (the numerator in the rate) without adding any work to the denominator. This fixed offset identical between the two engines has a bigger impact on the lower engine rating. In the extreme this can be seen easily. As the engine ratings decrease and approach zero, the brake work approaches zero and the calculated brake specific fuel consumption approaches infinity. For these reasons, we are proposing that the same selection criteria, as outlined in 40 CFR part 86, subpart N, be used to define a single engine family designation for both criteria pollutant and GHG emissions. Further, we are proposing that for fuel consumption and CO_2 emissions only any selective enforcement audits, in-use, confirmatory, or other compliance testing would be limited to the parent rating for the family. This approach is being contemplated for administrative convenience and we seek comments on alternatives to address compliance testing. Consistent with the current regulations, manufacturers may electively subdivide a grouping of engines which would otherwise meet the criteria for a single family if they have evidence that the emissions are different over the useful life.

The agency utilizes a 12-digit naming convention for all mobile-source engine families (and test groups for vehicles). This convention is also shared by the California Air Resources Board which allows manufacturers to potentially use a single family name for both EPA and California ARB certification. Of the 12 digits, 9 are EPA-defined and provide identifying characteristics of the engine family. The first digit represents the model year, through use of a predefined code. For example, "A" corresponds to the 2010 model year and "B" corresponds to the 2011 model year. The 5th position corresponds to the industry sector code, which includes such examples as light-duty vehicle (V) and heavy-duty diesel engines (H). The next three digits are a unique alphanumeric code assigned to each manufacturer by EPA. The next four digits describe the displacement of the engine; the units of which are dependent on the industry segment and a decimal may be used when the displacement is in liters. For engine families with multiple displacements, the largest displacement is used for the family name. For on-highway vehicles and engines, the tenth character is reserved for use by California ARB. The final characters (including the 10th character in absence of California ARB guidance) left to the manufacturer to determine, such that the family name forms a unique identifying characteristic of the engine family.

This convention is well understood by the regulated industries, provides sufficient detail, and is flexible enough to be used across a wide spectrum of vehicle and engine categories. In addition, the current harmonization with other regulatory bodies reduces complications for affected manufacturers. For these reasons, we are not proposing any major changes to this naming convention for this proposal. There may be additional categories defined for the 5th character to address heavy-duty vehicle test groups, however that will be discussed later.

As with criteria pollutant standards, the heavy-duty diesel regulatory category is subdivided into three regulatory subcategories, depending on the GVW of the vehicle in which the engine will be used. These regulatory subcategories are defined as light-heavy-duty (LHD) diesel, medium heavy-duty (MHD) diesel, and heavy heavy-duty (HHD) diesel engines. All heavy-duty gasoline engines are grouped into a single subcategory. Each of these regulatory subcategories are expected to be in service for varying amounts of time, so they each carry different regulatory useful lives. For this reason, expectations for demonstrating useful life compliance differ by subcategory, particularly as related to deterioration factors.

Light heavy-duty diesel engines (and all gasoline heavy-duty engines) have the same regulatory useful life as a light-duty vehicle (110,000 miles), which is significantly shorter than the other heavy-duty regulatory subcategories. Therefore, we believe it is appropriate to maintain commonality with the light-duty GHG rule. During the light-duty GHG rulemaking, the conclusion was reached that no significant deterioration would occur over the useful life. Therefore, EPA is proposing to specify that manufacturers would use assigned DFs for CO_2 and the values would be zero (for additive DFs) and one (for multiplicative DFs). EPA is interested in data that addresses this issue.

For the medium heavy-duty and heavy heavy-duty diesel engine segments, the regulatory useful lives are significantly longer (185,000 and 435,000 miles, respectively). For this reason, the agency is not convinced that engine/aftertreatment wear will not have a negative impact on GHG emissions. To address useful life compliance for MHD and HHD diesel engines certified to GHG standards, we believe the criteria pollutant approach for developing DFs is appropriate. Using CO_2 as an example, many of the engine deterioration concerns previously identified will affect CO_2 emissions. Reduced compression, as a result of wear, will cause higher fuel consumption and increase CO_2 production. In addition, as aftertreatment devices age (primarily particulate traps), regeneration events may become more frequent and take longer to complete. Since regeneration commonly requires an increase in fuel rate, CO_2 emissions would likely increase as well. Finally, any changes in EGR levels will affect heat release rates, peak combustion temperatures, and completeness of combustion. Since these factors could reasonably be expected to change fuel consumption, CO_2 emissions would be expected to change accordingly.

HHD diesel engines may also require some degree of aftertreatment maintenance throughout their useful life. For example, one major heavy-duty engine manufacturer specifies that their diesel particulate filters be removed and cleaned at intervals between 200,000 and 400,000 miles, depending on the severity of service. Another major engine manufacturer requires servicing diesel particulate filters at 300,000 miles. This maintenance or lack thereof if service is neglected, could have serious negative implications to CO_2 emissions. In addition, there may be emissions-related warranty implications for manufacturers to ensure that if rebuilding or specific emissions related maintenance is necessary, it will occur at the prescribed intervals. Therefore, it is imperative that manufacturers are detailed in their maintenance instructions. The agency currently seeks public comment on how to properly address this issue.

Lean-NO_X aftertreatment devices may also facilitate GHG reductions by allowing engines to run with higher engine-out NO_X levels in exchange for more efficient calibrations. In most cases, these aftertreatment devices require a consumable reductant, such as diesel exhaust fluid, which requires periodic maintenance by the vehicle operator. Without such maintenance, the emission control system may be compromised and compliance with emission standards may be jeopardized. Such maintenance is considered to be critical emission related maintenance and manufacturers must therefore demonstrate that it is likely to be completed at the required intervals. One example of such a demonstration is an engine power de-rate strategy that will limit engine power or vehicle speed in absence of this required maintenance.

If the manufacturer determines that maintenance is necessary on critical emission-related components within the useful life period, they must have a reasonable basis for ensuring that this maintenance will be completed as scheduled. This includes any adjustment, cleaning, repair, or replacement of critical emission-related components. Typically, the agency has only allowed manufacturers to schedule such maintenance if the manufacturer can demonstrate that the maintenance is reasonably likely to be done at the recommended intervals. This demonstration may be in the form of survey data showing at least 80 percent of in-use engines get the prescribed maintenance at the correct intervals. Another possibility is to provide the maintenance free of charge. We see no reason to depart from this approach for GHG-related critical emission-related components; however the agency welcomes commentary on this approach.

(b) Demonstrating Compliance With the Proposed Standards

(i) CO_2 Standards

The final test results (adjusted for deterioration, if applicable) form the basis for the Family Certification Limit (FCL), which the manufacturer must specify to be at or above the certification test results. This FCL becomes the emission standard for the family and any certification or confirmatory testing must show compliance with this limit. In addition, manufacturers may choose an FCL at any level above their certified emission level to provide a larger compliance margin. If subsequent certification or confirmatory testing reveals emissions above the FCL, the new, higher result becomes the FCL.

The FCL is also used to determine the Family Emission Limit (FEL), which serves as the emission limit for any subsequent field testing conducted after the time of certification. This would primarily include selective enforcement audits, but also may include in-use testing and/or production line testing for GHGs. The FEL differs from the FCL in that it includes an EPA-defined compliance margin; currently proposed to be 2 percent. Under this scenario the FEL would always be 2 percent higher than the FCL.

Engine Emission Testing

Under current non-GHG engine emissions regulations, manufacturers are required to demonstrate compliance using two test methods: The heavy-duty transient cycle and the heavy-duty steady state test. Each test is an engine speed versus engine torque schedule intended to be run on an engine dynamometer. Over each test, emissions are sampled using the equipment and procedures outlined in 40 CFR part 1065, which includes provisions for measuring CO_2, N_2O, and CH_4. Emissions may be sampled continuously or in a batch configuration (commonly known as "bag sampling") and the total mass of emissions over each cycle are normalized by the engine power required to complete the cycle. Following each test, a validation check is made comparing actual engine speed and torque over the cycle to the commanded values. If these values do not align well, the test is deemed invalid.

The transient Heavy-duty FTP cycle is characteristic of typical urban stop-and-go driving. Also included is a period of more steady state operation that would be typical of short cruise intervals at 45 to 55 miles per hour. Each transient test consists of two 20 minute tests separated by a "soak" period of 20 minutes. The first test is run with the engine in a "cold" state, which involves letting the engine cool to ambient conditions either by sitting overnight or by forced cooling provisions outlined in § 86.1335–90 (or 40 CFR part 1036). This portion of the test is meant to assess the ability of the engine to control emissions during the period prior to reaching normal operating temperature. This is commonly a challenging area in criteria pollutant emission control, as cold combustion chamber surfaces tend to inhibit mixing and vaporization of fuel and aftertreatment devices do not tend to function well at low temperatures.

Following the first test, the engine is shut off for a period of 20 minutes, during which emission analyzer checks are performed and preparations are made for the second test (also known as the "hot" test). After completion of the second test, the results from the cold and hot tests are weighted and a single composite result is calculated for each pollutant. Based on typical in-use duty cycles, the cold test results are given a 1/7 weighting and the hot test results are given a 6/7 weighting. Deterioration factors are applied to the final weighted results and the results are then compared to the emission standards.

Prior to 2007, compliance only needed to be demonstrated over the Heavy-duty FTP. However, a number of events brought to light the fact that this transient cycle may not be as well suited for engines which spend much of their duty cycle at steady cruise conditions, such as those used in line-haul semi-trucks. As a result, the steady-state SET procedure was added, consisting of 13 steady-state modes. During each mode, emissions were sampled for a period of five minutes. Weighting factors were then applied to each mode and the final weighted results were compared to the emission standards (including deterioration factors). In addition, emissions at each mode could not exceed the NTE emission limits. Alternatively, manufacturers could run the test as a ramped-modal cycle. In this case, the cycle still consists of the same speed/torque modes, however linear progressions between points are added and instead of weighting factors, each mode is sampled for various amounts of time. The result is a continuous cycle lasting approximately 40 minutes. With the implementation of part 1065 test procedures in 2010, manufacturers are now required to run the modal test as a ramped-modal cycle. In addition, the order of the speed/torque modes in the ramped-modal cycle have changed for 2010 and later engines.

It is well known that fuel consumption, and therefore CO_2 emissions, are highly dependent on the drive cycle over which they are measured. Steady cruise conditions, such as highway driving, tend to be more efficient, having lower fuel consumption and CO_2 emissions. In contrast, highly transient operation, such as city driving, tends to lead to lower efficiency and therefore higher fuel consumption and CO_2 emissions. One example of this is the difference between EPA-measured city and highway fuel economy ratings assigned to all new light-duty passenger vehicles.

For this heavy-duty engine and vehicle proposal, we believe it is important to assess CO_2 emissions and fuel consumption over both transient and steady state test cycles, as all vehicles will operate in conditions typical of each cycle at some point in their useful life. However, due to the drive cycle dependence of CO_2 emissions, we do not believe it is reasonable to have a single CO_2 standard which must be met for both cycles. A single CO_2 standard would likely prove to be too lax for steady-state conditions while being too strict for transient conditions. Therefore, the agencies are recommending that all heavy-duty engines be tested over both transient and steady-state tests. However, only the results from either the transient or steady-state test cycles would be used to assess compliance with GHG standards, depending on the type of vehicle in which the engine will be used. Engines that will be used in Class 7 and 8 tractors would use the ramped-modal cycle for GHG certification, and engines used in vocational vehicles would use the Heavy-duty FTP cycle. In both cases, results from the other test cycle would be reported but not used for a compliance decision. Engines will continue to be required to show criteria pollutant compliance over both cycles, in addition to NTE requirements.

The agencies propose that manufacturers submit both composite data sets, as well as modal data for criteria and GHG pollutants for engine certification. This would include submission of discrete mode results from the continuous analyzer data collected during the ramped-modal cycle test. This would also include providing both cold start and hot start transient heavy-duty FTP emissions results, as well as the composite emissions at the time of certification. In an effort to improve the accuracy of the simulation model being used for assessing CO_2 and fuel consumption performance and overall engine emissions performance, gaseous pollutants sampled using continuous analyzers (including but not limited to emissions results for CO_2, CO, and NO_X) would need to provide the constituent data from each of the test modes. The agencies welcome comment on this proposed requirement. As explained above in Section II, the agencies are proposing an alternative standard whereby manufacturers may elect that certain of their engine families meet an alternative percent reduction standard, measured from the engine family's 2011 baseline, instead of the main 2014 MY standard. As part of the certification process, manufacturers electing this standard would not only have to notify the agency of the election but also demonstrate the derivation of the 2011 baseline CO_2 emission level for the engine family. Manufacturers would also have to demonstrate that they have exhausted all credit opportunities.

Durability Testing

Another element of the current certification process is the requirement to complete durability testing to establish DFs. As previously mentioned, manufacturers are required to demonstrate that their engines comply with emission standards throughout the regulatory compliance period of the engine. This demonstration is commonly made through the combination of low-hour test results and testing based deterioration factors.

For engines without aftertreatment devices, deterioration factors primarily account for engine wear as service is accumulated. This commonly includes wear of valves, valve seats, and piston rings, all of which reduce in-cylinder pressure. Oil control seals and gaskets also deteriorate with age, leading to higher lubricating oil consumption. Additionally, flow properties of EGR systems may change as deposits accumulate and therefore alter the mass of EGR inducted into the combustion chamber. These factors, amongst others, may serve to reduce power, increase fuel consumption, and change combustion properties; all of which affect pollutant emissions.

For engines equipped with aftertreatment devices, DFs take into account engine deterioration, as described above, in addition to aging affects on the aftertreatment devices. Oxidation catalysts and other catalytic devices rely on active precious metals to effectively convert and reduce harmful pollutants. These metals may become less active with age and therefore pollutant conversion efficiencies may decrease. Particulate filters may also experience reduced trapping efficiency with age due to ash accumulation and/or degradation of the filter substrate, which may lead to higher tailpipe PM measurements and/or increased regeneration frequency. If a pollutant is predominantly controlled by aftertreatment, deterioration of emission control depends on the continued operation of the aftertreatment device much more so than on consistent engine-out emissions.

At this time, we anticipate that most engine component wear will not have a significant negative impact on CO_2 emissions. However, wear and aging of aftertreatment devices may or may not have a significant negative impact on CO_2 emissions. In addition, future engine or aftertreatment technologies may experience significant deterioration in CO_2 emissions performance over the useful life of the engine. For these reasons, we believe that the use of DFs for CO_2 emissions is both appropriate and necessary. As with criteria pollutant emissions, these DFs are preferably developed through testing the engine over a representative duty cycle for an extended period of time. This is typically either half or full useful life, depending on the regulatory class. The DFs are then calculated by comparing the high-hour to low-hour emission levels, either by division or subtraction (for multiplicative & additive DFs, respectively).

This testing process may be a significant cost to an engine manufacturer, mainly due to the amount of time and resources required to run the engine out to half or full useful life. For this reason, durability testing for the determination of DFs is not commonly repeated from model year to model year. In addition, some DFs may be allowed to carry over between families sharing a common architecture and aftertreatment system. EPA prefers to have manufacturers develop testing-based DFs for their products, and we are proposing that this be the case for the final rule. However, we do understand that for the reasons stated above, it may be impractical to expect manufacturers to have testing-based deterioration factors available for this proposal. Therefore, we are willing to consider requiring the use of assigned DFs for CO_2. Under this possibility, we suggest that manufacturers would be required to submit any CO_2 data from durability testing to aid in developing more accurate assigned DFs.

IRAFs/Regeneration Impacts on CO_2

Heavy-duty engines may be equipped with exhaust aftertreatment devices which require periodic "regeneration" to return the device to a nominal state. A common example is a diesel particulate filter, which accumulates PM as the engine is operated. When the PM accumulation reaches a threshold such that exhaust backpressure is significantly increased, exhaust temperature is actively increased to oxidize the stored PM. The increase in exhaust temperature is commonly facilitated through late combustion phasing and/or raw fuel injection into the exhaust system upstream of the filter. Both methods impact emissions and therefore must be accounted for at the time of certification. In accordance with § 86.004–28(i), this type of event would be considered infrequent because in most cases they only occur once every 30 to 50 hours of engine operation (rather than once per transient test cycle), and therefore adjustment factors must be applied at certification to account for these effects.

Similar to DFs, these adjustment factors are based off of manufacturer testing; however this testing is far less time consuming. Emission results are measured from two test cycles: With and without regeneration occurring. The differences in emission results are used, along with the frequency at which regeneration is expected to occur, to develop upward and downward adjustment factors. Upward adjustment factors are added to all emission results derived from a test cycle in which regeneration did not occur. Similarly, downward adjustment factors are subtracted from results based on a cycle which did experience a regeneration event. Each pollutant will have a unique set of adjustment factors and additionally, separate factors are commonly developed for transient and steady-state test cycles.

The impact of regeneration events on criteria pollutants varies by pollutant and the aftertreatment device(s) used. In general, the adjustment factor can have a very significant impact on compliance with the NO_X standard. For this reason, heavy-duty vehicle and engine manufacturers are already very well motivated to extend the regeneration frequency to as long an interval as possible and to reduce the regeneration as much as possible. Both of these actions significantly reduce the impact of regeneration on CO_2 emissions and fuel consumption. We do not believe that adding an adjustment factor for infrequent regeneration to the CO_2 or fuel efficiency standards would provide a significant additional motivation for manufacturers to reduce regenerations. Moreover, doing so would add significant and unnecessary uncertainty to our projections of CO_2 and fuel consumption performance in 2014 and beyond. In addressing that uncertainty, the agencies would have to set less stringent fuel efficiency and CO_2 standards for heavy-duty trucks and engines. Therefore, we are not proposing to include an infrequent regeneration adjustment factor for CO_2 or fuel efficiency in this program. The agencies are seeking public commentary on this approach.

Auxiliary Emission Control Devices

As part of the engine control strategy, there may be devices or algorithms which reduce the effectiveness of emission control systems under certain limited circumstances. These strategies are referred to as Auxiliary Emission Control Devices (AECDs). One example would be the reduced use of EGR during cold engine operation. In this case, low coolant temperatures may cause the electronic control unit to reduce EGR flow to improve combustion stability. Once the engine warms up, normal EGR rates are resumed and full NO_X control is achieved.

At the time of certification, manufacturers are required to disclose all AECDs and provide a full explanation of when the AECD is active, which sensor inputs effect AECD activation, and what aspect of the emission control system is affected by the AECD. Manufacturers are further required to attest that their AECDs are not "defeat-devices," which are intentionally targeted at reducing emission control effectiveness.

Several common AECDs disclosed for criteria pollutant certification will have a similarly negative influence on GHG emissions as well. One such example is cold-start enrichment, with provides additional fueling to stabilize combustion shortly after initially starting the engine. From a criteria pollutant perspective, HC emissions can reasonably be expected to increase as a result. From a GHG perspective, the extra fuel does not result in a similar increase in power output and therefore the efficiency of the engine is reduced, which has a negative impact on CO_2 emissions. In addition, there may be AECDs that uniquely reduce GHG emission control effectiveness. Therefore, consistent with today's certification procedures, we are proposing that a comprehensive list of AECDs covering both criteria pollutant, as well as GHG emissions is required at the time of certification.

(ii) EPA's N_2O and CH_4 Standards

In 2009, EPA issued rules requiring manufacturers of mobile-source engines to report the emissions of CO_2, N_2O, and CH_4 (74 FR 56260, October 30, 2009). While CO_2 is commonly measured during certification testing, CH_4 and N_2O are not. CH_4 has traditionally not been included in criteria pollutant regulations because it is a relatively stable molecule and does not contribute significantly to ground-level ozone formation. In addition, N_2O is commonly a byproduct of lean-NO_X aftertreatment systems. Until recently, these types of systems were not widely used on heavy-duty engines and therefore N_2O emissions were insignificant. Both species, while emitted in small quantities relative to

CO_2, have much higher global warming potential than CO_2 and therefore must be considered as part of a comprehensive GHG regulation.

EPA is proposing that CH_4 and N_2O be reported at the time of certification. We are proposing to allow manufacturers to use a compliance statement based on good engineering judgment for the first year of the program in lieu of direct measurement of N_2O. However, beginning in the 2015 model year, the agency is proposing to require the direct measurement of N_2O for certification. The intent of the CH_4 and N_2O standards are more focused on prevention of future increases in these compounds, rather than forcing technologies that reduce these pollutants. As one example, we envision manufacturers satisfying this requirement by continuing to use catalyst designs and formulations that appropriately control N_2O emissions rather than pursuing a catalyst that may increase N_2O. In many ways this becomes a design-based criterion in that the decision of one catalyst over another will effectively determine compliance with N_2O standards over the useful life of the engine. As noted in Section II above, we are not at this time aware of deterioration mechanisms for N_2O and CH_4 that would result in large deterioration factors, but neither do we believe enough is known about these mechanisms to justify proposing assigned factors corresponding to no deterioration. We are therefore asking for comment on this subject.

(c) Additional Compliance Provisions

(i) Warranty & Defect Reporting

Under section 207 of the CAA, engine manufacturers are required to warrant that their product is free from defects that would cause the engine to not comply with emission standards. This warranty must be applicable from when the engine is introduced into commerce through a period generally defined as half of the regulatory useful life (specified in hours and years, whichever comes first). The exact time of this warranty is dependent on the regulatory class of the engine. In addition, components that are considered "high cost" are required to have an extended warranty. Examples of such components would be exhaust aftertreatment devices and electronic control units.

Current warranty provisions in 40 CFR part 86 define the warranty periods and covered components for heavy-duty engines. The current list of components is comprised of any device or system whose failure would result in an increase in criteria pollutant emissions. At this point, we believe this list to be adequate for addressing GHG emissions as well. However, there may be instances where the failure of a component or system may reduce the efficiency of the engine while not increasing criteria pollutant emissions. In this case, the component or system may be inappropriately left off the list of covered components. Therefore we are seeking public comment on what devices and/or systems may need to be added to the warranted component list to adequately address GHG emissions. The following list identifies items commonly defined as critical emission-related components:

- Electronic control units.
- Aftertreatment devices.
- Fuel metering components.
- EGR-System components.
- Crankcase-ventilation valves.
- All components related to charge-air compression and cooling.
- All sensors and actuators associated with any of these components.

When a manufacturer experiences an elevated rate of failure of an emission control device, they are required to submit defect reports to the EPA. These reports will generally have an explanation of what is failing, the rate of failure, and any possible corrections taken by the manufacturer. Based on how successful EPA believes the manufacturer to be in addressing these failures, the manufacturer may need to conduct a product recall. In such an instance, the manufacturer is responsible for contacting all customers with affected units and repairing the defect at no cost to them. We believe this structure for the reporting of criteria pollutant defects, and recalls, is appropriate for components related to complying with GHG emissions as well.

(ii) Maintenance

Engine manufacturers are required to outline maintenance schedules that ensure their product will remain in compliance with emission standards throughout the useful life of the engine. This schedule is required to be submitted as part of the application for certification. Maintenance that is deemed to be critical to ensuring compliance with emission standards is classified as "critical emission-related maintenance." Generally, manufacturers are discouraged from specifying that critical emission-related maintenance is needed within the regulatory useful life of the engine. However, if such maintenance is unavoidable, manufacturers must have a reasonable basis for ensuring it is performed at the correct time. This may be demonstrated through several methods including survey data indicating that at least 80% of engines receive the required maintenance in-use or manufacturers may provide the maintenance at no charge to the user. During durability testing of the engine, manufacturers are required to follow their specified maintenance schedule.

Maintenance relating to components relating to reduction of GHG emissions are not expected to present unique challenges. Therefore, we are not proposing any changes to the provisions for the specification of emission-related maintenance as outlined in 40 CFR part 86.

(2) Proposed Enforcement Provisions

(a) Emission Control Information Labels

Current provisions for engine certification require manufacturers to equip their product with permanent emission control information labels. These labels list important characteristics, parameters, and specifications related to the emissions performance of the engine. These include, but are not limited to, the manufacturer, model, displacement, emission control systems, and tune-up specifications. In addition, this label also provides a means for identifying the engine family name, which can then be referenced back to certification documents. This label provides essential information for field inspectors to determine that an engine is in fact in the certified configuration.

We do not anticipate any major changes needing to be made to emission control information labels as a result of new GHG standards and a single label is appropriate for both criteria pollutant and GHG emissions purposes. Perhaps the most significant addition would be the inclusion of Family Certification Levels or Family Emission Limits for GHG pollutants, if the manufacturer is participating in averaging, banking, and trading. In addition, the label will need to indicate whether the engine is certified for use in vocational vehicles, tractors, or both.

(b) In-Use Standards

In-use testing of engines provides a number of benefits for ensuring useful life compliance. In addition to verifying compliance with emission standards at any given point in the useful life, it can be used along with manufacturer defect reporting, to indentify components failing at a higher than normal rate. In this case, a product recall or other service campaign can be initiated and the problem can be rectified. Another key benefit of in-use testing is the discouragement of control strategies catered to the certification test cycles. In the past, engine manufacturers were found to be producing engines that performed acceptably over the certification test cycle, while changing to alternate operating strategies "off-cycle" which caused increases in criteria pollutant emissions. While these strategies are clearly considered defeat devices, in-use testing provides a meaningful way of ensuring that such strategies are not active under normal engine operation.

Currently, manufacturers of certified heavy-duty engines are required to conduct in-use testing programs. The intent of these programs is to ensure that their products are continuing to meet criteria pollutant emission standards at various points within the useful life of the engine. Since initial certification is based on engine dynamometer testing, and removing in-use engines from their respective vehicles is often impractical, a unique testing procedure was developed. This includes using portable emission measurement systems (PEMS) and testing the engine over typical in-situ drive routes rather than a prescribed test cycle. To assess compliance, emission results from a well defined area of the speed/torque map of the engine, known as the NTE zone, are compared to the emission standards. To account for potential increases in measurement and operational variability, certain allowances are applied to the standard which results in the standard for NTE measurements (NTE limit) to be at or above the duty cycle emission standards.

In addition, EPA also conducts an annual in-use testing program of heavy-duty engines. Testing procured vehicles with specific engines over well-defined drive routes using a constant trailer load allows for a consistent comparison of in-use emissions performance. If potential problems are identified in-situ, the engine may be removed from the vehicle and tested using an engine dynamometer over the certification test cycles. If deficiencies are confirmed the agency will either work with the manufacturer to take corrective action or proceed with enforcement action against the manufacturer.

The GHG reporting rule requires manufacturers to submit CO_2 data from all engine testing (beginning in the 2011 model year), which we believe is equally applicable to in-use measurements. Methods of CO_2 in-situ measurement are well established and most, if not all, PEMS devices measure and record CO_2 along with criteria pollutants. CH_4 and N_2O present in-situ measurement challenges that may be impractical to overcome for this testing, and therefore it is not recommended that they be included in in-use testing requirements at this time. While measurement of CO_2 may be practical and important, implementing an NTE emission standard for CO_2 is challenging. As previously discussed, CO_2 emissions are highly dependent on the drive cycle of the vehicle, which does not lend itself well to the NTE-based test procedure. Therefore, we propose that manufacturers be required to submit CO_2 data from in-use testing, in both g/bhp-hr and g/ton-mile, but these data will be used for reference purposes only (there would be no NTE limit/standard for CO_2).

(3) Other Certification Provisions

(a) Carryover/Carry Across Certification Test Data

EPA's current certification program for heavy-duty engines allows manufacturers to carry certification test data over and across certification testing from one model year to the next, when no significant changes to models are made. EPA is proposing to also apply this policy to CO_2, N_2O and CH_4 certification test data.

(b) Certification Fees

The CAA allows EPA to collect fees to cover the costs of issuing certificates of conformity for the classes of engines covered by this proposal. On May 11, 2004, EPA updated its fees regulation based on a study of the costs associated with its motor vehicle and engine compliance program (69 FR 51402). At the time that cost study was conducted, the current rulemaking was not considered. At this time the extent of any added costs to EPA as a result of this proposal is not known. EPA will assess its compliance testing and other activities associated with the rule and may amend its fees regulations in the future to include any warranted new costs.

(c) Onboard Diagnostics

Beginning in the 2013 model year, manufacturers will be required to equip heavy-duty engines with on-board diagnostic systems. These systems monitor the activity of the emission control system and issue alerts when faults are detected. These diagnostic systems are currently being developed based around components and systems that influence criteria pollutant emissions. Consistent with the light-duty vehicle GHG rule, we believe that monitoring of these components and systems for criteria pollutant emissions will have an equally beneficial effect on CO_2 emissions. Therefore, we do not anticipate the necessity of having any unique onboard diagnostic provisions for heavy-duty GHG emissions. We are seeking comment on this topic, however.

(d) Applicability of Current High Altitude Provisions to Greenhouse Gases

EPA is proposing that engines covered by this proposal must meet CO_2, N_2O and CH_4 standards at elevated altitudes. The CAA requires emission standards under section 202 for heavy-duty engines to apply at all altitudes. EPA does not expect engine CO_2, CH_4, or N_2O emissions to be significantly different at high altitudes based on engine calibrations commonly used at all altitudes. Therefore, EPA proposes that it retain its current high altitude regulations so manufacturers will not normally be required to submit engine CO_2 test data for high altitude. Instead, they will be required to submit an engineering evaluation indicating that common calibration approaches will be utilized at high altitude. Any deviation in emission control practices employed only at altitude will need to be included in the AECD descriptions submitted by manufacturers at certification. In addition, any AECD specific to high altitude will be required to include emissions data to allow EPA evaluate and quantify any emission impact and validity of the AECD.

(e) Emission-Related Installation Instructions

Engine manufacturers are currently required to provide detailed installation instructions to vehicle manufacturers. These instructions outline how to properly install the engine, aftertreatment, and other supporting systems, such that the engine will operate in its certified configuration. At the time of certification, manufacturers may be required to submit these instructions to EPA to verify that sufficient detail has been provided to the vehicle manufacturer.

We do not anticipate any major changes to this documentation as a result of regulating GHG emissions. The most significant impact will be the addition of language prohibiting vehicle manufacturers from installing engines into vehicle categories in which they are not certified for. An example would be a tractor manufacturer installing an engine certified for only vocational vehicle use. Explicit instructions on behalf of the engine manufacturer that such acts are prohibited will serve as sufficient notice to the vehicle manufacturers and failure to follow such instructions will in the vehicle manufacturer being in non-compliance.

(f) Alternate CO_2 Emission and Fuel Consumption Standards

Under the proposed rule, engine manufacturers have the option of certifying to CO_2 emission and fuel consumption standards that are 5 percent below a baseline value established from their 2011 model-year products. If a manufacturer elects to participate in this program they must indicate this on their certification application. In addition, sufficient details must be submitted regarding the baseline engine such that the agency can verify that the correct optional CO_2 emission and fuel consumption standards have been calculated. This data will need to include the engine family name of the baseline engine, so references to the original certification application can be made, as well as test data showing the CO_2 emissions and fuel consumption of the baseline engine.

D. Class 7 and 8 Combination Tractors

(1) Proposed Compliance Approach

In addition to requiring engine manufacturers to certify their engines, manufacturers of Class 7 and 8 combination tractors must also certify that their vehicles meet the proposed CO_2 emission and fuel consumption standards. This vehicle certification will ensure that efforts beyond just engine efficiency improvements are undertaken to reduce GHG emissions and fuel consumption. Some examples include aerodynamic improvements, rolling resistance reduction, idle reduction technologies, and vehicle speed limiting systems.

Unlike engine certification however, this certification would be based on a load-specific basis (g/ton-mile or gal/1,000 ton-mile as opposed to work-based, or g/bhp-hr). This would take into account the anticipated vehicle loading that would be experienced in use and the associated affects on fuel consumption and CO_2 emissions. Vehicle manufacturers would also be required to warrant their products against emission defects, and demonstrate that a service network is in place to correct any such conditions. The vehicle manufacturer also bears responsibility in the event that an emission-related recall is necessary.

(a) Certification Process

In order to obtain a certificate of conformity for the tractor, vehicle manufacturers would complete a compliance demonstration, showing that their product meets emission standards as well as other regulatory requirements. For purposes of this demonstration, vehicles with similar emission characteristics throughout their useful life are grouped together in test groups, similar to EPA's light-duty emissions certification program. Examples of characteristics that would define a test group for heavy-duty vehicles are wheel and tire package, aerodynamic profile, tire rolling resistance, and engine model. Under this system, the worst-case vehicle would be selected based on having the highest fuel consumption, and all other models within the family are assumed to have emissions and fuel consumption at or below the parent model and therefore in compliance with CO_2 emission and fuel consumption standards. Any vehicle within the family can be subject to selective enforcement auditing in addition to confirmatory or other administrator testing.

We anticipate test groups for Class 7 and 8 combination tractors to utilize the standardized 12-digit naming convention, as outlined in the engine certification section of this chapter. As with engines, each certifying vehicle manufacturer will have a unique three digit code assigned to them. Currently, there is no 5th digit (industry sector) code for this class of vehicles, for which we propose to use the next available character, "2." Since we are proposing that the engine is one of several test-group defining features, we still believe it is appropriate to include engine displacement in the family name. If the test-group consists includes multiple engine models with varying displacements, the largest would be specified in the test-group name, consistent with current practices. The remaining characters would remain available for California ARB and/or manufacturer use, such that the result is a unique test-group name.

Class 7 and 8 tractors share several common traits, such as the trailer attachment provisions, number of wheels, and general construction. However, further inspection reveals key differences related to GHG emissions. Payloads hauled by Class 7 tractors are significantly less than Class 8 tractors. In addition, Class 8 vehicles may have provisions for hoteling ("sleeper cabs"), which results in an increase in size as well as the addition of comfort features like power and climate control for use while the truck is parked. Both segments may have various degrees of roof fairing to provide better aerodynamic matching to the trailer being pulled. This is a feature which can help reduce CO_2 emissions significantly when properly matched to the trailer, but can also increase CO_2 emissions if improperly matched. Based on these differences, it is reasonable to expect differences in CO_2 emissions, and therefore these properties form the basis for the proposed combination tractor regulatory subcategories.

The various combinations of payload, cab size, and roof profile result in nine proposed regulatory subcategories for Class 7 and 8 trucks. These include Class 7 (day cabs), Class 8 (day cabs), and Class 8 (sleeper cabs), each with high, mid, and low roof profiles. The Class 7 tractors would have a regulatory useful life of 185,000 miles while Class 8 tractors would have a regulatory life of 435,000 miles and must meet CO_2 emission standards throughout this period.

(b) Demonstrating Compliance With the Proposed Standards

(i) CO_2 and Fuel Consumption Standards

Consistent with existing certification processes for light-duty vehicles and heavy-duty pickups and vans, emissions testing of the complete vehicle would be the preferred method for demonstrating compliance with vehicle emission standards. However, vehicle-level certification is new to the heavy-duty vehicle segment above 14,000 lb. Therefore, most vehicle manufacturers are not adequately equipped to conduct vehicle-level emission testing for Class 7 and 8 combination tractors. Chassis dynamometers, emission sampling equipment, and staff engineering support are a few of the factors that would add significant cost to vehicle development in a relatively short amount of time, which may make the prospect of vehicle testing quite onerous. In addition to the infrastructure and testing facilities the industry would need to add, the agencies have not completed the extensive work ultimately desirable for us to propose new test procedures and standards based on the use of a chassis test procedure. Moreover, as explained in Section II.C, because of the enormous numbers of truck configurations that have an impact on fuel consumption, we do not believe that it would be reasonable, at least initially, to require testing of many combinations of tractor model configurations on a chassis dynamometer. Recognizing these constraints related to time, staffing, and capital, we are proposing only a vehicle simulation model option for demonstrating compliance at the time of certification. However, we do believe that a chassis based test procedure as currently utilized for vehicles below 14,000 pounds could be a better long-term approach to regulate all heavy-duty vehicles and we are seeking comment on a chassis based approach.

Model

Vehicle modeling will be conducted using the agencies' simulation model, GEM, which is described in detail in Chapter 4 of the draft RIA. Basically, this model functions by defining a vehicle configuration and then exercises the model over various drive cycles. Several initialization files are needed to define a vehicle, which include mechanical attributes, control algorithms, and driver inputs. The majority of these inputs will be predetermined by EPA and NHTSA for the purposes of vehicle certification. The net results from GEM are CO_2 emissions and fuel consumption values over the proposed drive cycles. The CO_2 emission result will be used for demonstrating compliance with vehicle CO_2 standards while the fuel consumption result will be used for demonstrating compliance with the fuel consumption standards.

The vehicle manufacturer will be responsible for entering aerodynamic properties of the vehicle, the weight reduction, tire properties, idle reduction systems, and vehicle speed limiting systems. For GEM inputs relating to weight reduction and aerodynamics, the agencies are proposing the use of lookup tables based on typical performance levels across the industry. These lookup tables do not have data directly related to CO_2, but rather provide the appropriate coefficients for the model to assess CO_2- and fuel consumption-related performance. The agencies will enter the appropriate engine map reflecting use of a certified engine in the truck (and will enter the same value even if an engine family is certified to the temporary percent reduction alternative standard, in order to evaluate vehicle performance independently of engine performance.) We believe this approach reduces the testing burden placed upon manufacturers, yet adequately assesses improvements associated with select technologies. The model will be publicly available and will be found on EPA's Web site.

The agency reserves the right to independently evaluate the inputs to the model via Administrator testing to validate those model inputs. The agency also reserves the right to evaluate vehicle performance using the inputs to the model provided by the manufacturer to confirm the performance of the system using GEM. This could include generating emissions results using the GEM and the inputs as provided by the manufacturer based on the agency's own runs. This could also include conducting comparable testing to verify the inputs provided by the manufacturer. In the event of such testing or evaluation, the Administrator's results become the official certification results. The exception being that the manufacturer may continue to use their data as initially submitted, provided it represents a worst-case condition over the Administrator's results.

To better facilitate the entry of only the appropriate parameters, the agencies will provide a graphical user interface in the model for entering data specific to each vehicle. This graphical user interface allows the end user to avoid interacting directly with the model and any associated coding. It is expected that this template will be submitted to EPA as part of the certification process for each certified vehicle configuration.

For certification, the model will exercise the vehicle over three test cycles; one transient and two steady-state. For the transient test, we are proposing to use the heavy-heavy-duty diesel truck (HHDDT) transient test cycle, which was developed by the California Air Resources Board and West Virginia University to evaluate heavy-duty vehicles. The transient mode simulates urban, start-stop driving, featuring 1.8 stops per mile over the 2.9 mile duration. The two steady state test points are reflective of the tendency for some of these vehicles to operate for extended periods at highway speeds. Based on data from the EPA's MOVES database, and common highway speed limits, we are proposing these two points to be 55 and 65 mph.

The model will predict the total emissions results from each segment using the unique properties entered for each vehicle. These results are then normalized to the payload and distance covered, so as to yield a gram/ton-mile result, as well as a fuel consumption (gal/1,000 ton-mile) result for each test cycle. As with engine and vehicle testing, certification will be based on a parent rating for the test group, representing the worst-case fuel consumption and CO_2 emissions. However, vehicle manufacturers will also have the opportunity to model sub-configurations to determine any benefits that are available on only a select number of vehicles within a test group.

The results from all three tests are then combined using weighting factors, which reflect typical usage patterns. The typical usage characteristics of Class 7 and 8 tractors with day cabs differ significantly from Class 8 tractors with sleeper cabs. The trucks with day cabs tend to operate in more urban areas, have a limited travel range, and tend to return to a common depot at the end of each shift. Class 8 sleeper cabs, however, are typically used for long distance trips which consist of mostly highway driving in an effort to cover the highest mileage in the shortest time. For these reasons, we propose that the cycles are weighted differently for these two groups of vehicles. For Class 7 and 8 trucks with day cabs, we propose weights of 64%, 17%, and 19% (65 mph, 55 mph, and transient, resp.). For Class 8 with sleeper cabs, the high speed cruise tendency results in proposed weights of 86%, 9%, and 5% (65 mph, 55 mph, and transient, respectively). These final, weighted emission results are compared to the emission standard to assess compliance.

Durability Testing

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.

The category of vehicle attributes generally refers to aerodynamic features, such as fairings, side-skirts, air dams, air foils, *etc,* which are installed by the manufacturer to reduce aerodynamic drag on the vehicle. These features have a significant impact on GHG emissions and their emission reduction properties are assessed early in the useful life (at the time of certification). These features are expected to last the full life of the vehicle without becoming detached, cracked/broken, misaligned, or otherwise not in the original state. In the absence of the aforementioned failure modes, the performance of these features is not expected to degrade over time and the benefit to reducing GHG emissions is expected to last for the life of the vehicle with no special maintenance requirements. To assess useful life compliance, we recommend a design-based approach which would ensure that the manufacturer has robustly designed these features so they can reasonably be expected to last the useful life of the vehicle.

The category of maintenance items refers to items that are replaced, renewed, cleaned, inspected, or otherwise addressed in the preventative maintenance schedule specified by the vehicle manufacturer. Items that have a direct influence on GHG emissions are primarily lubricants. 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.

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. This is based on the assumption that as components wear, the rolling resistance due to friction is likely to stay the same or decrease. With all other components remaining equal (tires, aerodynamics, *etc*), the overall drag force would stay the same or decrease, thus not significantly changing GHG emissions at the end of useful life. It is important to remember however, that this vehicle assessment does not take into account any engine-related wear affects, which may in fact increase GHG emissions over time.

For the reasons explained above, we believe that for the first phase of this program, it is most important to ensure that the vehicle remain in its certified configuration throughout the useful life. This can most effectively be accomplished through engineering analysis and specific maintenance instructions provided by the vehicle manufacturer. The vehicle manufacturer would be primarily responsible for providing engineering analysis demonstrating that vehicle attributes will last for the full life of the vehicle. In addition they will be required to submit the recommended maintenance schedule (and other service related documentation), showing that fluids meeting original equipment properties are required as replacements.

(ii) EPA's Air Conditioning Leakage Standards

Heavy-duty vehicle air conditioning systems contribute to GHG emissions in two ways. First, operation of the air conditioning unit places an accessory load on the engine, which increases fuel consumption. Second, most modern refrigerants are HFC-based, which have significant global warming potential (GWP = 1430). For heavy-duty vehicles, the load added by the air conditioning system is comparatively small compared to other power requirements of the vehicle. Therefore, we are not targeting any GHG reduction due to decreased air conditioning usage or higher efficiency A/C units for this proposal. However, refrigerant leakage, even in very small quantities, can have significant adverse effects on GHG emissions.

Refrigerant leakage is a concern for heavy-duty vehicles, similar to light-duty vehicles. To address this, EPA is proposing a design-based standard for reducing refrigerant leakage from heavy-duty vehicles. This standard is based off using the best practices for material selection and interface sealing, as outlined in SAE publication J2727. Based on design criteria in this publication, a leakage "score" can be assessed and an estimated annual leak rate can be made for the A/C system based on the refrigerant capacity.

At the time of certification, manufacturers would be required to outline the design of their system, including specifying materials and construction methods. They will also need to supply the leakage score developed using SAE J2727 and the refrigerant volume of their system to determine the leakage rate per year. If the certifying manufacturer does not complete installation of the air conditioning unit, detailed instructions must be provided to the final installer which ensures that the A/C system is assembled to meet the low-leakage standards. These instructions will also need to be provided at the time of certification, and manufacturers must retain all records relating to auditing of the final assembler.

(c) In-Use Standards

As previously addressed, the drive-cycle dependence of CO_2 emissions makes NTE-based in-use testing impractical. In addition, we believe the reporting of CO_2 data from the criteria pollutant in-use testing program will be helpful in future rulemaking efforts. For these reasons, we are not proposing an NTE-based in-use testing program for Class 7 and 8 combination tractors during this proposal.

In the absence of NTE-based in-use testing, provisions are necessary for verifying that production vehicles are in the certified configuration, and remain so throughout the useful life. Perhaps the easiest method for doing this is to verify the presence of installed emission-related components. This would basically consist of a vehicle audit against what is claimed in the certification application. This includes verifying the presence of aerodynamic components, such as fairings, side-skirts, and gap-reducers. In addition, the presence of idle-reduction and speed limiting devices would be verified. The presence of LRR tires could be verified at the point of initial sale; however verification at other points throughout the useful life would be non-enforceable for the reasons mentioned previously.

The category of wear items primarily relates to tires. It is expected that vehicle manufacturers will equip their trucks with LRR tires, as they may provide a substantial reduction in GHG emissions. The tire replacement intervals for this class of vehicle is normally in the range of 50,000 to 100,000 miles, which means the owner/operator will be replacing the tires at several points within the useful life of the vehicle. We believe that as LRR tires become more common on new equipment, the aftermarket prices of these tires will also decrease. Along with decreasing tire prices, the fuel savings realized through use of LRR tires will ideally provide enough incentive for owner/operators to continue purchasing these tires. The inventory modeling in this proposal reflects the continued use of LRR tires through the life of the vehicle. We seek comment on this and all aspects of our inventory modeling.

(2) Proposed Enforcement Provisions

As identified above, a significant amount of vehicle-level GHG reduction is anticipated to come from the use of components specifically designed to reduce GHG emissions. Examples of such components include LRR tires, aerodynamic fairings, idle reduction systems, and vehicle speed limiters. At the time of certification, vehicle manufacturers will specify which components will be on their vehicle when introduced into commerce. Based on this list of components reported to EPA the GHG performance of the vehicle will be assessed, typically through modeling, and a certificate of conformity may be issued. As described in the in-use testing section, it is important to have the ability to determine if the vehicle is in the certified configuration both at the time of sale, as well as at any point within the useful life.

Perhaps the most practical and basic method of verifying that a vehicle is in its certified configuration is through a vehicle emissions control information label, similar to that used for engines and light-duty vehicles. This label would list identifying features of the vehicle, including model year, vehicle model, certified engine family, vehicle manufacturer, test group, and GHG emissions category. In addition, this label would list emission-related components that an inspector could reference in the event of a field inspection. Possible examples may include LRR (for LRR tires), ARF (aerodynamic roof fairing), and ARM (aerodynamic rearview mirrors). With this information, inspectors could verify the presence and condition of attributes listed as part of the certified configuration.

Similarly, on current emission control information labels, manufacturers list abbreviations, which are defined in SAE J1930, for each emission control device. Examples include three-way catalyst (TWC), electronic control (EC), and heated oxygen sensor (HO_2S). Unfortunately we are not aware of a similar, existing list of vehicle emission control devices and features likely to be used on heavy-duty vehicles. At this point, it is also difficult to develop such a list due to the wide array of devices and features vehicle manufacturers may use in the future. Therefore, we are currently seeking comment on how to best define a list of emission control devices and features for use in this vehicle GHG certification label.

At the time of certification, manufacturers will be required to submit an example of their vehicle emission control label such that EPA can verify that all critical elements are present. Such elements include the vehicle family/test group name, emission control system identifiers described above, regulatory sub-category of the vehicle, and Family Emission Limits to which the vehicle is certified to. In addition to the label, manufacturers will also need to describe where the unique vehicle identification number and date of production can be found on the vehicle.

(3) Other Certification Provisions

(a) 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. In addition, this warranty must ensure that the vehicle remains in this configuration throughout its useful life. For purposes of this regulation, vehicle manufacturers must warrant all components installed which act to reduce CO_2 emissions at the time of initial sale. This includes all aerodynamic features, tires, idle reduction systems, speed limiting system, and other equipment added to reduce CO_2 emissions. In addition, the manufacturer must ensure these components and systems remain functional for the useful life of the vehicle. The exception being tires, which are only required to be warranted for the first life of the tires (vehicle manufacturers are not expected to cover replacement tires). For aerodynamic features, such as fairings or side-skirts, the manufacturer must warrant against failures which are not the result operator damage. However, these components should be designed to withstand possible damage from normal driving, which may include stone impingement and other minor impact with small debris.

The vehicle manufacturer is also required to warrant the A/C system for the useful life of the vehicle against design or manufacturing defects causing refrigerant leakage in excess of the standard.

At the time of certification, manufacturers must supply a copy of the warranty statement that will be supplied to the end customer. This document should outline what is covered under the GHG emissions related warranty as well as the length of coverage. Customers must also have clear access to the terms of the warranty, the repair network, and the process for obtaining warranty service.

(b) Maintenance

Vehicle manufacturers are required to outline maintenance schedules that ensure their product will remain in compliance with emission standards throughout the useful life of the vehicle. For heavy-duty vehicles, such maintenance may include fluid/lubricant service, fairing adjustments, or service to the GHG emission control system. This schedule is required to be submitted as part of the application for certification. Maintenance that is deemed to be critical to ensuring compliance with emission standards is classified as "critical emission-related maintenance." Generally, manufacturers are discouraged from specifying that critical emission-related maintenance is needed within the regulatory useful life of the engine. However, if such maintenance is unavoidable, manufacturers must have a reasonable basis for ensuring it is performed at the correct time. This may be demonstrated through several methods including survey data indicating that at least 80% of engines receive the required maintenance in-use or manufacturers may provide the maintenance at no charge to the user.

(c) Certification Fees

Similar to engine certification, the agency will assess certification fees for heavy-duty vehicles. The proceeds from these fees are used to fund the compliance and certification activities related to GHG regulation for this regulatory category. In addition to the certification process, other activities funded by certification fees include EPA-administered in-use testing, selective enforcement audits, and confirmatory testing. At this point, the exact costs associated with the heavy-duty vehicle GHG compliance are not well known. EPA will assess its compliance program associated with this proposal and assess the appropriate level of fees. We anticipate that fees will be applied based on test groups, following the light-duty vehicle approach.

(d) Requirements For Conducting Aerodynamic Assessment Using Allowed Methods

The requirements for conducting aerodynamic assessment using allowed methods includes two key components: Adherence to a minimum set of standardized criteria for each allowed method and submittal of aerodynamic values and supporting information on an annual basis for the purposes of certifying vehicles to a particular aerodynamic bin as discussed in the Section II.

First, we are proposing requirements for conducting each of the allowed aerodynamic assessment methods. We will cite approved and published standards and practices, where feasible, but will attempt to propose criteria where none exists or where more current research indicates otherwise. We are requesting comment on the proposed requirements for each allowed method, standards and practices that should be used, and any unique criteria that we are proposing. A description of the requirements for each method is discussed later in this section. The manufacturer would be required to provide information showing that they meet these requirements and attest to the accuracy of the information provided.

Second, to ensure continued compliance, manufacturers would be required to provide a minimum set of information on an annual basis at certification time (1) to support continued use of an aerodynamic assessment method and (2) to assign an aerodynamic value based on the applicable aerodynamic bins. The information supplied to the agencies should be based on an approved aerodynamic assessment method and adhere to the requirements for conducting aerodynamic assessment mentioned above.

Regardless of the method, all testing should be performed with a tractor-trailer combination to mimic real world usage. Accordingly, it is important to match the type of tractor with the correct trailer. Although, as discussed elsewhere in this proposal, the correct tractor-trailer combination is not always present or tractor-only operation may occur, the majority of operation in the real world involves correctly matched tractor-trailer combinations and we will attempt to reflect that here. Therefore, the following guidelines should be used when performing an aerodynamic assessment:

- For a Class 7 and 8 tractor truck with a low roof, a standard flatbed trailer must be used;
- For a Class 7 and 8 tractor truck with a mid roof, a standard tanker trailer must be used;
- For a Class 7 and 8 tractor truck with a high roof, a standard box trailer must be used.

The definitions of each standard trailer are proposed in § 1037.501(g). This ensures consistency and continuity in the aerodynamic assessments, and maintains the overlap with real world operation.

Standardized Criteria for Aerodynamic Assessment Methods

(i) Coastdown Procedure Requirements

For coastdown testing, the test runs should be conducted in a manner consistent with SAE J2263 with additional modifications as described in the 40 CFR part 1066, subpart C, and in Chapter 3 of the draft RIA using the mixed model analysis method. The agencies seek comment on the use of these protocols and the modifications that are described.

Since the coastdown procedure is the primary aerodynamic assessment method, the manufacturer would be required to conduct the coastdown procedure according to the requirements in this proposal and supply the following to the agency for approval:

- Facility information: Name and location, description and/or background/history, equipment and capability, track and facility elevation, and track size/length;
- 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 model engine family, tire type and rolling resistance, test weight and driver name(s) and/or ID(s);
- Average Cd result as calculated in 40 CFR 1037.520(b) from valid tests including, at a minimum, ten valid test results, with no maximum number, standard deviation, calculated error and error bands, and total number of tests, including number of voided or invalid tests.

(ii) Wind Tunnel Testing Requirements

Wind tunnel testing would conform to the following procedures and modifications, where applicable, including:

- SAE J1252, "SAE WIND TUNNEL TEST PROCEDURE FOR TRUCKS AND BUSES" (July 1981) except that article 5.2 that specifies a minimum Reynolds number of 0.7×10^6 is not included and is superseded, for the purposes of this rulemaking, by a minimum Reynolds number of 1.0×10^6 and, for reduced-scale wind tunnel testing, a one-eighth (⅛th) or larger scale model of a heavy-duty tractor and trailer must be used and of sufficient design to simulate airflow through the radiator inlet grill;
- J1594, "VEHICLE AERODYNAMICS TERMINOLOGY" (December 1994); and
- J2071, "AERODYNAMIC TESTING OF ROAD VEHICLES—OPEN THROAT WIND TUNNEL ADJUSTMENT" (June 1994).

In addition, the wind tunnel used for aerodynamic assessment would be a recognized facility by the Subsonic Aerodynamic Testing Association. The agencies seek comment on the use of these protocols and the modifications described and the need for membership in this testing association.

For wind tunnel testing, we are proposing that manufacturers perform wind tunnel testing and the coastdown procedure, according to the requirements proposed in this notice, on the same tractor model and provide the results for both methods. The wind tunnel tests should be conducted at a zero yaw angle and, if so equipped, utilizing the moving/rolling floor (*i.e.,* the moving/rolling floor should be on during the test as opposed to static) for comparison to the coastdown procedure, which corrects to a zero yaw angle for the oncoming wind. The manufacturer would be required to supply the following:

- Facility information: Name and location, description and background/history, layout, wind tunnel type, diagram of wind tunnel layout, structural and material construction;
- Wind tunnel design details: Corner turning vane type and material, air settling, mesh screen specification, air straightening method, tunnel volume, surface area, average duct area, and circuit length;
- Wind tunnel 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;
- 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;
- Fan section description: Fan type, diameter, power, maximum rotational speed, maximum tip speed, support type, mechanical drive, sectional total weight;
- 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;
- 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; and
- Facility correction factors and purpose.

(iii) CFD Requirements

Currently, there is no existing standard, protocol or methodology governing the use of CFD. Therefore, we are coupling the use of CFD with empirical measurements from coastdown and wind tunnel procedures. However, we think it is important to require a minimum set of criteria that all CFD analysis should follow for the purpose of these rules and to produce a consistent set of results to maintain compliance. Since there are primarily two-types of CFD software code, Navier-Stokes based and Lattice-Boltzman based, we are outlining two sets of criteria to address both types. Therefore, the agencies propose that manufacturers use commercially-available CFD software code with a turbulence model enabled and Navier-Stokes formula solver, where applicable. Further details and criteria for each type of commercially-available CFD software code follows immediately and general criteria for all CFD analysis are subsequently described.

For Navier-Stokes based CFD code, manufacturers must perform an unstructured, time-accurate analysis using a mesh grid size with total surface elements greater than or equal to 5 million cells/nodes, a near-vehicle cell size of less than or equal to 10 millimeters (mm), a near-wall cell size of less than or equal to 1mm,[203] and a volume element size of less than or equal to 5 mm; using hexagonal or polyhedral mesh cell shapes. All Navier-Stokes based CFD analysis should be performed with a k-epsilon (k-ε) or a shear stress transport k-omega (SST k-ω) turbulence model and mesh deformation enabled with boundary layer resolution of +/− 95%. Finally, Navier-Stokes based CFD analysis for the purposes of determining the Cd should be performed once result convergence is achieved and manufacturers should be able to demonstrate convergence by supplying multiple, successive convergence values.

For Lattice-Boltzman based CFD code, the agencies propose that manufacturers perform an unstructured, time-accurate analysis using a mesh grid size with total surface elements greater than or equal to 5 million cells/nodes, a near-vehicle cell size of less than or equal to 10 millimeters (mm), a near-wall cell size of less than or equal to 1mm, and a volume element size of less than or equal to 5 mm; using cubic volume elements and triangle and/or quadrilateral surface elements.

Finally, in general for CFD, all analysis should be conducted assuming zero yaw angle for comparison to the coastdown test procedure. In addition, the ambient conditions assumed for the CFD analysis should be defined according to the environmental conditions that the manufacturer is seeking to simulate. For simulating a wind tunnel test, the CFD analysis should accurately model that wind tunnel and assume a wind tunnel blockage ratio consistent with SAE J1252 or that matches the selected wind tunnel, whichever is lower. For simulation of open road conditions similar to that experienced during coastdown test procedures, the CFD analysis should assume a blockage ratio of less than or equal 0.2%.

The agencies seek comment on the use of CFD commercial or open source code and the criteria set forth above for conducting the analysis.

Finally, in general for each of the allowed aerodynamic assessment methods, we are requesting comment on the list of information that must be provided for facilities and test conditions.

Annual Testing and Data Submittal for Aerodynamic Assessment

Once the manufacturer has performed acceptance demonstration, the aerodynamic assessment can be used to generate Cd values for all vehicle models the manufacturer plans to certify and introduce into commerce. For each model, the manufacturer would supply a predicted Cd based for each of the other models in the manufacturer's fleet and the other conditions used to determine the base Cd. This reduces burden on the manufacturer to perform aerodynamic assessment but provides data for all the models in a manufacturer's fleet. If a manufacturer has previously performed aerodynamic assessment on the other models, the manufacturer may submit an experimental Cd in lieu of a predicted Cd.

The aerodynamic assessment data would be used by the manufacturer who would input the Cd value from the look-up table, based on the results from the aerodynamic assessment, into GEM and determine a GHG emissions and fuel consumption level.

Since the agency may input the data into the model, manufacturers would provide the information described above for acceptance demonstration for the purposes of annual certification. In addition, the manufacturer would supply manufacturer fleet information to the agency for annual certification purposes along with the acceptance demonstration parameters: manufacturer name, model year, model line (if different than manufacturer name), model name, engine family, engine displacement, transmission name and type, number of axles, axle ratio, vehicle dimensions, including frontal area, predicted or measured coefficient of drag, assumptions used in developing the predicted or measured Cd. justification for carry-across of aerodynamic assessment data, photos of the model line-up, if available, and model applications and usage options.

We are requesting comment on the annual testing requirements and the burden on manufacturers to satisfy the requirements.

(e) Aerodynamic Assessment Validation and Compliance

Although the procedures above should ensure accuracy in the aerodynamic assessment, it is always beneficial to perform confirmation or validation post-certification. The agencies would like to ensure a level playing field among the manufacturers and the different aerodynamic assessment methods. The agencies hope to finalize a method for doing so after working through the comments from all stakeholders in a collaborative manner.

The agencies envision that a program for aerodynamic assessment could consist of two parts: (1) Validation of the manufacturer source data by performing an audit of the manufacturer's aerodynamic assessment methods and tools as described in this proposal using a reference truck and/or (2) vehicle confirmatory evaluation using a vehicle recruited from the in-use fleet and performing the aerodynamic assessment discussed in this proposal, either using the manufacturer's facility and tools or using the agency's facility and tools. We are seeking comment on the all aspects of an aerodynamic assessment validation and compliance.

E. Class 2b–8 Vocational Vehicles

(1) Proposed Compliance Approach

Like Class 7 and 8 combination tractors, heavy-duty vocational vehicles would be required to have both engine and complete vehicle certificates of conformity. As discussed in the engine certification section, engines that will be used in vocational vehicles would need to be certified using the Heavy-duty FTP cycle for GHG pollutants and show compliance through the useful life of the engine. This certification is in addition to the current requirements for obtaining a certificate of conformity for criteria pollutant emissions.

For this proposal, the majority of the GHG reduction for vocational vehicles is expected to come from the use of LRR tires as well as increased utilization of hybrid powertrain systems. Other technologies such as aerodynamic improvements and vehicle speed limiting systems are not as relevant for this class of vehicles, since the typical duty cycle is much more urban, consisting of lower speeds and frequent stopping. Idle reduction strategies are expected to be encompassed by hybrid technology, which we anticipate will ultimately handle PTO operation. Therefore, for this initial proposal, certification of heavy-duty vocational vehicles with conventional powertrains will focus on quantifying GHG benefits due to the use of LRR tires.

[203] *See* Lecture Notes in Applied and Computational Mechanics, The Aerodynamics of Heavy Vehicles II: Trucks, Buses, and Trains; DOI: 10.1007/978–3–540–85070–0_33; "Applicability of Commercial CFD tools for assessment of heavy vehicle aerodynamic characteristics" as created by the University of Chicago as Operator of Argonne National Laboratory ("Argonne") under contract No. W–31–109–ENG–38 with the U.S. Department of Energy.

(a) Certification Process

Vehicles would be divided into test groups for purposes of certification. As with Class 7 and 8 combination tractors, these are groups of vehicles within a given regulatory category that are expected to share common emission characteristics. Vocational vehicle regulatory subcategories share the same structure as those used for heavy-duty engine criteria pollutant certification and are based on GVWR. This includes light-heavy (LHD) with a GVWR at or below 19,500 pounds, medium-heavy (MHD) with a GVWR above 19,500 pounds and at or below 33,000 pounds, and heavy-heavy (HHD) with a GVWR above 33,000 pounds. Other test group features may include the type of tires used, intended application, and number of wheels.

As with Class 7 and 8 combination tractors, we anticipate using the standardized 12-digit naming convention to identify vocational vehicle test groups. As with engines and Class 7 and 8 combination tractors, each certifying vehicle manufacturer would have a unique three digit code assigned to them. Currently, there is no 5th digit (industry sector) code for this class of vehicles, for which we propose to use the next available character, "3." Since we are proposing that the engine is one of several test-group defining features, we still believe it is appropriate to include engine displacement in the family name. If the test-group consists includes multiple engine models with varying displacements, the largest would be specified in the test-group name, consistent with current practices. The remaining characters would remain available for California ARB and/or manufacturer use, such that the result is a unique test-group name.

Each test group would need to demonstrate compliance with emission standards using the GEM approach. Additional provisions are available for certification of hybrid vehicles or vehicles using unique technologies, which was detailed in Section IV. If the test group consists of multiple models, only result from the worst-case model is necessary for certification. However, manufacturers would need to submit an engineering evaluation demonstrating that the test group has been assembled appropriately and that the test model indeed reflects the worst-case model. Also, manufacturers should plan on submitting tire rolling resistance properties to EPA at the time of certification. Finally the data from each of the certification cycles described below will need to be submitted at the time of certification.

(b) Demonstrating Compliance With the Proposed Standards

(i) CO_2 and Fuel Consumption Standards

Model

For this proposal, the agencies are proposing that demonstrating compliance with GHG and fuel consumption standards would primarily involve demonstrating the use of LRR tires and quantifying the associated CO_2 and fuel consumption benefit. Similar to Class 7 and 8 combination tractors, this will be done using GEM. However, the input parameters entered by the vehicle manufacturer would be limited to the properties of the tires. GEM will use the tire data, along with inputs reflecting a baseline truck and engine, to generate a complete vehicle model. The test weight used in the model will be based on the vehicle class, as identified above. Light-heavy-duty vehicles will have a test weight of 16,000 pounds; 25,150 pounds for medium heavy-duty vehicles; and heavy heavy-duty vocational vehicles will use a test weight of 67,000 pounds. The model would then be exercised over the HHDDT transient cycle as well as 55 and 65 mph steady-state cruise conditions. The results of each of the three tests would be weighted at 37%, 21%, and 42% for 65 mph, 55 mph, and transient tests, respectively.

It may seem more expedient and just as accurate to require manufacturers use tires meeting certain industry standards for qualifying tires as having LRR. In addition, CO_2 and fuel consumption benefits could be quantified for different ranges of coefficients of rolling resistance to provide a means for comparison to the standard. However, we believe that as technology advances, other aspects of vocational vehicles may warrant inclusion in future rulemakings. For this reason, we believe it is important to have the certification framework in place to accommodate such additions. While the modeling approach may seem to be overly complicated for this phase of the rules, it also serves to create a certification pathway for future rulemakings and therefore we believe this is the best approach. Should innovative technologies be considered that are currently beyond the scope of the model, it would be necessary for the manufacturer to conduct A to B testing which reflects the improvement associated with the new technology. The test protocol to be used and the basis of this assessment will require a public vetting process which would likely include notice and comment.

In-use Standards

The category of wear items primarily relates to tires. It is expected that vehicle manufacturers will equip their trucks with LRR (LRR) tires, since the proposed vehicle standard is predicated on LRR tires' performance. The tire replacement intervals for this class of vehicle is normally in the range of 50,000 to 100,000 miles, which means the owner/operator will be replacing the tires at several points within the useful life of the vehicle. We believe that as LRR tires become more common on new equipment, the aftermarket prices of these tires will also decrease. Along with decreasing tire prices, the fuel savings realized through use of LRR tires will ideally provide enough incentive for owner/operators to continue purchasing these tires. The inventory modeling in this proposal reflects the continued use of LRR tires through the life of the vehicle. We seek comment on this and all aspects of our inventory modeling.

(ii) Evaporative Emission Standards

Evaporative and refueling emissions from heavy-duty highway engines and vehicles are currently regulated under 40 CFR part 86. Even though these emission standards apply to the same engines and vehicles that must meet exhaust emission standards, we require a separate certificate for complying with evaporative and refueling emission standards. An important related point to note is that the evaporative and refueling emission standards always apply to the vehicle, while the exhaust emission standards may apply to either the engine or the vehicle. For vehicles other than pickups and vans, the standards proposed in this notice to address greenhouse gas emissions apply separately to engines and to vehicles. Since we plan to apply both greenhouse gas standards and evaporative/refueling emission standards to vehicle manufacturers, we believe it would be advantageous to have the regulations related to their certification requirements written together as much as possible. EPA regards these proposed changes as discrete, minimal, and for the most part clarifications to the existing standards. Except as specifically proposed here, EPA is not soliciting comment on, or otherwise considering whether to make changes to those standards. Accordingly, EPA will not consider any comments directed to any aspect of these standards other than those specifically proposed here.

We are generally not proposing to change the evaporative or refueling emission standards, but we have come across several provisions that warrant clarification or correction:

• When adopting the most recent evaporative emission change we did not carry through the changes to the regulatory text applying evaporative emission standards for methanol-fueled compression-ignition engine. The proposed regulations correct this by applying the new standards to all fuels that are subject to standards.

• We are proposing provisions to address which standards apply when an auxiliary (nonroad) engine is installed in a motor vehicle, which is currently not directly addressed in the highway regulation. The proposed approach would require testing complete vehicles with any auxiliary engines (and the corresponding fuel-system components). Incomplete vehicles would be tested without the auxiliary engines, but any such engines and the corresponding fuel-system components would need to meet the standards that apply under our nonroad program as specified in 40 CFR part 1060.

• We are proposing to remove the option for secondary vehicle manufacturers to use a larger fuel tank capacity than is specified by the certifying manufacturer without re-certifying the vehicle. Secondary vehicle manufacturers needing a greater fuel tank capacity would need to either work with the certifying manufacturer to include the larger tank, or go through the effort to re-certify the vehicle itself. Our understanding is that this provision has not been used and would be better handled as part of certification rather than managing a separate process. We are proposing corresponding changes to the emission control information label.

• Rewriting the regulations in a new part in conjunction with the greenhouse gas standards allows for some occasions of improved organization and clarity, as well as updating various provisions. For example, we are proposing a leaner description of evaporative emission families that does not reference sealing methods for carburetors or air cleaners. We are also clarifying how evaporative emission standards affect engine manufacturers and proposing more descriptive provisions related to certifying vehicles above 26,000 pounds GVWR using engineering analysis.

• Since we adopted evaporative emission standards for gaseous-fuel vehicles, we have developed new approaches for design-based certification (*see,* for example, 40 CFR 1060.240). We request comment on changing the requirements related to certifying gaseous-fuel vehicles to design-based certification. This would allow for a simpler assessment for certifying these vehicles without changing the standards that apply.

(2) Proposed Labeling Provisions

It is crucial that a means exist for allowing field inspectors to identify whether a vehicle is certified, and if so, whether it is in the certified configuration. As with engines and tractors, we believe an emission control information label is a logical first step in facilitating this identification. For vocational vehicles, the engine will have a label that is permanently affixed to the engine and identify the engine as certified for use in a certain regulatory subcategory of vehicle (*i.e.,* MHD, *etc.*).

The vehicle will also have a label listing the test group, engine family, and range of tire rolling resistances that the vehicle is certified to use. In addition, if any other emission related components are present, such as hybrid powertrains, key components will also need to be specified on the label. Like the engine label, this will need to be permanently affixed to the vehicle in an area that is clearly accessible to the owner/operator.

At the time of certification, manufacturers will be required to submit an example of their vehicle emission control label such that EPA can verify that all critical elements are present. Such elements include the vehicle family/test group name, emission control system identifiers described above, regulatory sub-category of the vehicle, and Family Emission Limits to which the vehicle is certified to. In addition to the label, manufacturers will also need to describe where the unique vehicle identification number and date of production can be found on the vehicle.

(3) Other Certification Issues

Warranty

As with other heavy-duty engine and vehicle regulatory categories, vocational vehicle chassis manufacturers would be required to warrant their product to be free from defects that would adversely affect emissions. This warranty also covers the failure of emission related components for the useful life of the vehicle. For vocational chassis, the key emission related component addressed in this proposal is the tires.

Manufacturers of chassis for vocational vehicles would be required to warrant tires to be free from defects at the time of initial sale. As with Class 7 and 8 combination tractors, we expect the chassis manufacturer to only warrant tires the original tires against manufacturing or design-related defects. This tire warranty would not cover replacement tires or damage from road hazards or improper inflation.

As with Class 7 and 8 combination tractors, all warranty documentation would be submitted to EPA at the time of certification. This should include the warranty statement provided to the owner/operator, description of the service repair network, list of covered components (both conventional and high-cost), and length of coverage.

EPA Certification Fees

Similar to engine and tractor-trailer vehicle certification, the agency will assess certification fees for vocational vehicles. The proceeds from these fees are used to fund the compliance and certification activities related to GHG regulation for this industry segment. In addition to the certification process, other activities funded by certification fees include EPA-administered in-use testing, selective enforcement audits, and confirmatory testing. At this point, the exact costs associated with the heavy-duty vehicle GHG compliance are not well known. EPA will assess its compliance program associated with this proposal and assess the appropriate level of fees. We anticipate that fees will be applied based on test groups, following the light-duty vehicle approach.

Maintenance

Vehicle manufacturers are required to outline maintenance schedules that ensure their product will remain in compliance with emission standards throughout the useful life of the vehicle. For heavy-duty vehicles, such maintenance may include fluid/lubricant service, fairing adjustments, or service to the GHG emission control system. This schedule is required to be submitted as part of the application for certification. Maintenance that is deemed to be critical to ensuring compliance with emission standards is classified as "critical emission-related maintenance." Generally, manufacturers are discouraged from specifying that critical emission-related maintenance is needed within the regulatory useful life of the engine. However, if such maintenance is unavoidable, manufacturers must have a reasonable basis for ensuring it is performed at the correct time. This may be demonstrated through several methods including survey data indicating that at least 80% of engines receive the required maintenance in-use or manufacturers may provide the maintenance at no charge to the user.

F. General Regulatory Provisions

(1) Statutory Prohibited Acts

Section 203 of the CAA describes acts that are prohibited by law. This section and associated regulations apply equally to the greenhouse gas standards as to any other regulated emission. Acts that are prohibited by section 203 of the CAA include the introduction into commerce or the sale of an engine or vehicle without a certificate of conformity, removing or otherwise defeating emission control equipment, the sale or installation of devices designed to defeat emission controls, and other actions. In addition, vehicle manufacturers, or any other party, may not make changes to the certified engine that would result in it not being in the certified configuration.

EPA proposes to apply § 86.1854–12 to heavy-duty vehicles and engines; this codifies the prohibited acts spelled out in the statute. Although it is not legally necessary to repeat what is in the CAA, EPA believes that including this language in the regulations provides clarity and improves the ease of use and completeness of the regulations. Since this change merely codifies provisions that already apply, there is no burden associated with the change.

(2) Regulatory Amendments Related to Heavy-Duty Engine Certification

We are proposing to adopt the new engine-based greenhouse gas standards in 40 CFR part 1036 and the new vehicle-based standards in 40 CFR part 1037. We are proposing to continue to rely on 40 CFR parts 85 and 86 for conventional certification and compliance provisions related to criteria pollutants, but the proposed regulations include a variety of amendments that would affect the provisions that apply with respect to criteria pollutants. We are not intending to change the stringency of, or otherwise substantively change any existing standards.

The introduction of new parts in the CFR is part of a long-term plan to migrate all the regulatory provisions related to highway and nonroad engine and vehicle emissions to a portion of the CFR called Subchapter U, which consists of 40 CFR parts 1,000 through 1299. We have already adopted emission standards, test procedures, and compliance provisions for several types of engines in 40 CFR parts 1033 through 1074. We intend eventually to capture all the regulatory requirements related to heavy-duty highway engines and vehicles in these new parts. Moving regulatory provisions to the new parts allows us to publish the regulations in a way that is better organized, reflects updates to various certification and compliance procedures, provides consistency with other engine programs, and is written in plain language. We have already taken steps in this direction for heavy-duty highway engines by adopting the engine-testing procedures in 40 CFR part 1065 and the provisions for selective enforcement audits in 40 CFR part 1068.

EPA solicits comment on these proposed drafting changes and additions. This solicitation relates solely to the appropriate migration, translation, and enhancement of existing provisions. EPA is not soliciting comment on the substance of these existing rules, and is not proposing to amend, reconsider, or otherwise re-examine these provisions' substantive effect.

The rest of this section describes the most significant of these proposed redrafting changes. The proposal includes several changes to the certification and compliance procedures, including the following:

- We propose to require that engine manufacturers provide installation instructions to vehicle manufacturers (*see* § 1036.130). We expect this is already commonly done; however, the regulatory language spells out a complete list of information we believe is necessary to properly ensure that vehicle manufacturers install engines in a way that is consistent with the engine's certificate of conformity.
- § 1036.30, § 1036.250, and § 1036.825 spell out several detailed provisions related to keeping records and submitting information to us.
- We wrote the greenhouse gas regulations to divide heavy-duty engines into "spark-ignition" and "compression-ignition" engines, rather than "Otto-cycle" and "diesel" engines, to align with our terminology in all our nonroad programs. This will likely involve no effective change in categorizing engines except for natural gas engines. To address this concern, we would include a provision in § 1036.150 to allow manufacturers to meet standards for spark-ignition engines if they were regulated as Otto-cycle engines in 40 CFR part 86, and vice versa.
- § 1036.205 describes a new requirement for imported engines to describe the general approach to importation (such as identifying authorized agents and ports of entry), and identifying a test lab in the United States where EPA can perform testing on certified engines. These steps are part of our ongoing effort to ensure that we have a compliance and enforcement program that is as effective for imported engines as for domestically produced engines. We have already adopted these same provisions for several types of nonroad engines.
- § 1036.210 specifies a process by which manufacturers are able to get preliminary approval for EPA decisions for questions that require lead time for preparing an application for certification. This might involve, for example, preparing a plan for durability testing, establishing engine families, identifying adjustable parameters, and creating a list of scheduled maintenance items.
- § 1036.225 describes how to amend an application for certification.
- We are proposing to apply the exemption and recall provisions as written in 40 CFR part 1068 instead of the comparable provisions in 40 CFR part 85. This involves only minor changes relative to current practice.

We are aware that it may be appropriate to move several additional provisions in 40 CFR parts 85 and 86 to subchapter U. For example, highway engine manufacturers may find it preferable to use the same parameters specified for defining nonroad engine families for certifying highway engines. To the extent that the nonroad provisions would apply appropriately for highway engines, we and the manufacturers would benefit from a consistent approach to certifying both types of engines in a way that does not compromise the degree of emission control achieved under the existing standards.

Another area of particular interest is defect reporting. Existing regulations require manufacturers to report defects to EPA whenever the same defect occurs at least 25 times. This approach can be somewhat onerous for manufacturers making high-volume products. For example, for an engine model with annual sales above 25,000, this represents a defect rate of less than 0.1 percent. In contrast, the approach to defect reporting in § 1068.501 accommodates the high sales volumes associated with highway engines, basing requirements on a *percentage* of defective products, rather than setting a fixed number for all engine families. This flexibility is paired with the explicit direction for the manufacturer to actively monitor warranty claims, customer complaints, and other sources of information to evaluate and track potential defects. We believe this aligns both with the manufacturers' interest in producing quality products and EPA's interest in addressing any quality concerns that arise from the need to repair in-use engines and vehicles.

(3) Test Procedures For Measuring Emissions From Heavy-Duty Vehicles

We are proposing a new part 1066 that would contain a general chassis-based test procedures in for measuring emissions from a variety of vehicles, including vehicles over 14,000 pounds GVWR. However, we are not proposing to apply these procedures broadly at this time. The test procedures in 40 CFR part 86 would continue to apply for vehicles under 14,000 pounds GVWR. Rather, the proposed part 1066 procedures would apply only for any testing that would be required for larger vehicles. This could include "A to B" hybrid vehicle testing and coastdown testing. Nevertheless, we will likely consider in the future applying these procedures also for other heavy-duty vehicle testing and for light-duty vehicles, highway motorcycles, and/or nonroad recreational vehicles that rely on chassis-based testing.

As noted above, engine manufacturers are already using the test procedures in 40 CFR part 1065 instead of those originally adopted in 40 CFR part 86. The new procedures are written to apply generically for any type of engine and include the current state of technology for measurement instruments, calibration procedures, and other practices. We are proposing the chassis-based test procedures in part 1066 to have a similar structure.

The proposed procedures in part 1066 reference large portions of part 1065 to align test specifications that apply equally to engine-based and vehicle-based testing, such as CVS and analyzer specifications and calibrations, test fuels, calculations, and definitions of many terms. Since several highway engine manufacturers were involved in developing the full range of specified procedures in part 1065, we are confident that many of these provisions are appropriate without modification for vehicle testing.

The remaining test specifications needed in part 1066 are mostly related to setting up, calibrating, and operating a chassis dynamometer. This also includes the coastdown procedures that are required for establishing the dynamometer load settings to ensure that the dynamometer accurately simulates in-use driving.

Current testing requirements related to dynamometer specifications rely on a combination of regulatory provisions, EPA guidance documents, and extensive know-how from industry experience that has led to a good understanding of best practices for operating a vehicle in the laboratory to measure emissions. We attempted in this proposal to capture this range of material, organizing these specifications and verification and calibration procedures to include a complete set of provisions to ensure that a dynamometer meeting these specifications would allow for carefully controlled vehicle operation such that emission measurements are accurate and repeatable. We request comment on the range of proposed requirements related to designing, building, and operating chassis dynamometers. For example, we believe that the proposed verification and calibration procedures in part 1066, subpart B, for diameter, speed, torque, acceleration, base inertia, friction loss, and other parameters are all necessary to ensure proper dynamometer operation. It may be that some of these checks are redundant, or could be achieved with different procedures. There may also be additional checks needed to remove possibilities for inadequate accuracy or precision.

The procedures are written with the understanding that heavy-duty highway manufacturers have, and need to have, single-roll electric dynamometers for testing. We are aware that this is not the case for other applications, such as all-terrain vehicles. We are not adopting specific provisions for testing with hydrokinetic dynamometers, we are already including a provision acknowledging that we may approve the use of dynamometers meeting alternative specifications if that is appropriate for the type of vehicle being tested and for the level of stringency represented by the corresponding emission standards.

Drafting a full set of test specifications highlights the mixed use of units for testing. Some chassis-based standards and procedures are written based largely on the International System of Units (SI), such as gram per kilometer (g/km) standards and kilometers per hour (kph) driving, while others are written based largely on English units (g/mile standards and miles per hour driving). The proposal includes a mix of SI and English units with instructions about converting units appropriately. However, most of the specifications and examples are written in English units. While this seems to be the prevailing practice for testing in the United States, we understand that vehicle testing outside the United States is almost universally done in SI units. In any case, dynamometers are produced with the capability of operating in either English or SI units. We believe there would be a substantial advantage toward the goal of achieving globally harmonized test procedures if we would write the test procedures based on SI units. This would also in several cases allow for more straightforward calculations, and reduced risk of rounding errors. For comparison, part 1065 is written almost exclusively in SI units. We request comment on the use of units throughout part 1066.

A fundamental obstacle toward using SI units is the fact that some duty cycles are specified based on speeds in miles per hour. To address this, it would be appropriate to convert the applicable driving schedules to meter-per-second (m/s) values. Converting speeds to the nearest 0.01 m/s would ensure that the prescribed driving cycle does not change with respect to driving schedules that are specified to the nearest 0.1 mph. The regulations would include the appropriate mph (or kph) speeds to allow for a ready understanding of speed values (*see* 40 CFR part 1037, Appendix I). This would, for example, allow for drivers to continue to follow a mph-based speed trace. The ± 2 mph tolerance on driving speeds could be converted to ± 1.0 m/s, which corresponds to an effective speed tolerance of ± 2.2 mph. This may involve a tightening or loosening of the existing speed tolerance, depending on whether manufacturers used the full degree of flexibility allowed for a mph tolerance value that is specified without a decimal place. Similarly, the Cruise cycles for heavy-duty vehicles could be specified as 24.5 ± 0.5 m/s (54.8 ± 1.1 mph) and 29.0 ± 0.5 m/s (64.9 ± 1.1 mph).

G. Penalties

As part of the fuel efficiency improvement program to be created through this rulemaking, NHTSA is proposing civil penalties for non-compliance with fuel consumption standards. NHTSA's authority under EISA, as codified at 49 U.S.C. 32902(k), requires the agency to determine appropriate measurement metrics, test procedures, standards, and compliance and enforcement protocols for HD vehicles. NHTSA interprets its authority to develop an enforcement program to include the authority to determine and assess civil penalties for non-compliance, that would impose penalties determined based on the discussion that follows.

NHTSA proposes that in cases of non-compliance, the agency would establish civil penalties based on consideration of the following factors:

- Actual fuel consumption performance related to the applicable standard.
- Estimated cost to comply with the regulation and applicable standard.

• Quantity of vehicles or engines not complying.
• Manufacturer's history of non-compliance.
• The civil penalty should act as a deterrent.
• The financial condition of the manufacturer.
• Civil penalties paid for non-compliance of the same vehicles under the EPA GHG program.

NHTSA recognizes that EPA also has authority to impose civil penalties for non-compliance with GHG regulations. It is not the intent of either agency to impose duplicative civil penalties, and in the case of non-compliance with fuel consumption regulations, NHTSA intends to give consideration to civil penalties imposed by EPA for GHG non-compliance, as EPA would give consideration to civil penalties imposed by NHTSA in the case of non-compliance with GHG regulations.[204]

The proposed civil penalty amount NHTSA could impose would not exceed the limit that EPA is authorized to impose under the CAA. The potential maximum civil penalty for a manufacturer would be calculated as follows in Equation V–1:

Equation V–1: Aggregate Maximum Civil Penalty

Aggregate Maximum Civil Penalty for a Non-Compliant Regulatory Category = (CAA Limit) × (production volume within the regulatory category)

NHTSA seeks comments related to this proposal for a civil penalty program under EISA.

EPA has occasionally in the past conducted rulemakings to provide for nonconformance penalties—monetary penalties that allow a manufacturer to sell engines or vehicles that do not meet an emissions standard. Nonconformance penalties are authorized for heavy-duty engines and vehicles under section 206(g) of the CAA. Three basic criteria have been established by rulemaking for determining the eligibility of emissions standards for nonconformance penalties in any given model year: (1) The emissions standard in question must become more difficult to meet, (2) substantial work must be required in order to meet the standard, and (3) a technological laggard must be likely to develop (40 CFR 86.1103–87). A technological laggard is a manufacturer who cannot meet a particular emissions standard due to technological (not economic) difficulties and who, in the absence of nonconformance penalties, might be forced from the marketplace. The process to determine if these criteria are met and to establish penalty amounts and conditions is carried out via rulemaking, as required by the CAA. The CAA (in section 205) also lays out requirements for the assessment of civil penalties for noncompliance with emissions standards.

As discussed in detail in Section III, the agencies have determined that the proposed GHG and fuel consumption standards are readily feasible, and we do not believe a technological laggard will emerge in any sector covered by these proposed standards. In addition to the standards being premised on use of already-existing, cost-effective technologies, there are a number of flexibilities and alternative standards built into the proposal. However, we do request comment regarding this assessment and on whether or not it would be appropriate for EPA and NHTSA to initiate rulemaking activity to set nonconformance penalties for the proposed standards, subject to their respective statutory authorities. Should nonconformance penalties be warranted, the benefits of establishing them would be threefold: (1) The EPA and NHTSA programs would continue to be equivalent, allowing manufacturers to sell the same vehicles and engines to satisfy both programs, (2) competitiveness in the affected HD sector would be maintained, preserving jobs and consumer choices, and (3) nonconformance penalties would be set through a transparent public process, involving notice and public hearing.

VI. How would this proposed program impact fuel consumption, GHG emissions, and climate change?

A. What methodologies did the agencies use to project GHG emissions and fuel consumption impacts?

EPA and NHTSA used EPA's official mobile source emissions inventory model named Motor Vehicle Emissions Simulator (MOVES2010),[205], to estimate emission and fuel consumption impacts of these proposed rules. MOVES has capability to take in user inputs to modify default data to better estimate emissions for different scenarios, such as different regulatory alternatives, state implementation plans (SIPs), geographic locations, vehicle activity, and microscale projects.

The agencies performed multiple MOVES runs to establish reference case and control case emission inventories and fuel consumption values. The agencies ran MOVES with user input databases that reflected characteristics of the proposed rules, such as emissions improvements and recent sales projections. Some post-processing of the model output was required to ensure proper results. The agencies ran MOVES for non-GHGs, CO_2, CH_4, and N_2O for calendar years 2005, 2018, 2030, and 2050. Additional runs were performed for just the three greenhouse gases and for fuel consumption for every calendar year from 2014 to 2050, inclusive, which fed the economy-wide modeling, monetized benefits estimation, and climate impacts analysis.

The agencies also used MOVES to estimate emissions and fuel consumption impacts for the other alternatives considered and described in Section IX.

B. MOVES Analysis

(1) Inputs and Assumptions

(a) Reference Run Updates

Since MOVES2010 vehicle sales and activity data were developed from AEO2006, EPA first updated these data using sales and activity estimates from AEO2010. EPA also updated the fuel supply information in MOVES to reflect a 100% E10 "gasoline" fuel supply to reflect the Renewable Fuels Standard.[206] MOVES2010 defaults were used for all other parameters to estimate the reference case emissions inventories.

(b) Control Run Updates

EPA developed additional user input data for MOVES runs to estimate control case inventories. To account for improvements of engine and vehicle efficiency, EPA developed several user inputs to run the control case in MOVES. Since MOVES does not operate based on Heavy-duty FTP cycle results, EPA used the percent reduction in engine CO_2 emissions expected due to the proposed rules to develop energy inputs for the control case runs. Also, EPA used the percent reduction in aerodynamic drag coefficient and tire rolling resistance coefficient expected from the proposed rules to develop road load input for the control case. The fuel supply update used in the reference case was used in the control case. Details of all the MOVES runs, input

[204] EPA discussed a similar situation concerning consideration of civil penalties imposed by NHTSA for CAFE violations for light-duty vehicles, in the final rule establishing the 2012–2016 MY standards. *See* 75 FR 25324 and 25482, May 7, 2010.

[205] MOVES homepage: *http://www.epa.gov/otaq/models/moves/index.htm.* Version MOVES2010 was used for emissions impacts analysis for this proposal. Current version as of September 14, 2010 is an updated version named MOVES2010a, available directly from the MOVES homepage. To replicate results from this proposal, MOVES2010 must be used.

[206] Renewable Fuels Standard available at *http://www.epa.gov/otaq/fuels/renewablefuels/index.htm.*

data tables, and post-processing are available in the docket (EPA–HQ–OAR–2010–0162).

Table VI–1 and Table VI–2 describe the estimated expected reductions from these proposed rules, which were input into MOVES for estimating control case emissions inventories.

Table VI-1: Estimated Reductions in Engine CO_2 Emission Rates[207]

GVWR Class	Fuel	Model Years	CO_2 Reduction from 2010 MY
HHD (8a-8b)	Diesel	2014-2016	3%
		2017+	6%
MHD (6-7) and LHD 4-5	Diesel	2014-2016	5%
		2017+	9%
	Gasoline	2016+	5%

Table VI-2: Estimated Reductions in Rolling Resistance and Aerodynamic Drag Coefficients

Truck type	Reduction in tire rolling resistance coefficient from 2010 MY	Reduction in Cd from 2010 MY
Combination long-haul	8.4%	7.2%
Combination short-haul	7.0%	5.3%
Straight trucks, refuse trucks, motor homes, transit buses, and other vocational vehicles	10.0%	0%

Since nearly all HD pickup trucks and vans will be certified on a chassis dynamometer, the CO_2 reductions for these vehicles will not be represented as engine and road load reduction components, but total vehicle CO_2 reductions. These estimated reductions are described in Table VI–3.

Table VI-3: Estimated Total Vehicle CO_2 Reductions for HD Pickup Trucks and Vans

GVWR Class	Fuel	Model year	CO_2 Reduction from Baseline
HD Pickup Trucks and Vans	Gasoline	2014	1.5%
		2015	2%
		2016	4%
		2017	6%
		2018+	10%
	Diesel	2014	2.3%
		2015	3%
		2016	6%
		2017	9%
		2018+	15%

[207] Section II discusses an alternative engine standard proposed for the HD diesel engines in the 2014, 2015, and 2016 model years. To the extent that engines using this alternative would be expected to have baseline emissions greater than the industry average, the reduction from the industry average projected in this proposal could be reduced.

(C) What are the projected reductions in fuel consumption and GHG emissions?

EPA and NHTSA expect significant reductions in GHG emissions and fuel consumption from these proposed rules—emission reductions from both downstream (tailpipe) and upstream (fuel production and distribution) sources, and fuel consumption reductions from more efficient vehicles. Increased vehicle efficiency and reduced vehicle fuel consumption would also reduce GHG emissions from upstream sources. The following subsections summarize the GHG emissions and fuel consumption reductions expected from these proposed rules.

(1) Downstream (Tailpipe)

EPA used MOVES to estimate downstream GHG inventories from these proposed rules. We expect reductions in CO_2 from all heavy-duty vehicle categories. The reductions come from engine and vehicle improvements. EPA expects CH_4 and N_2O emissions to increase very slightly because of a rebound in vehicle miles traveled (VMT) and because significant vehicle reductions of these two GHGs are not expected from these proposed rules. Overall, downstream GHG emissions will be reduced significantly, and is described in the following subsections.

For CO_2 and fuel consumption, the total energy consumption "pollutant" was run in MOVES rather than CO_2 itself. The energy was converted to fuel consumption based on fuel heating values assumed in the Renewable Fuels Standard and used in the development of MOVES emission and energy rates. These values are 117,250 kJ/gallon for E10 [208] and 138,451 kJ/gallon for diesel.[209] To calculate CO_2, the agencies assumed a CO_2 content of 8,576 g/gallon for E10 and 10,180 g/gallon for diesel. Table VI–4 shows the fleet-wide GHG reductions and fuel savings from reference case to control case through the lifetime of model year 2014 through 2018 heavy-duty vehicles. Table VI–5 shows the downstream GHG emissions reductions and fuel savings in 2018, 2030, and 2050.

Table VI-4 Model Year 2014 through 2018 Lifetime GHG Reductions and Fuel Savings by Heavy-duty Truck Category

	Downstream GHG Reductions (MMT CO_2eq)	Fuel Savings (billion gallons)
HD pickups/vans	21	2.2
Vocational	35	3.4
Combination short-haul (Day cabs)	45	4.4
Combination long-haul (Sleeper cabs)	106	10.4

Table VI-5: Annual Downstream GHG Emissions Reductions and Fuel Savings in 2018, 2030, and 2050

	Downstream GHG Reductions (MMT CO_2eq)	Diesel Savings (million gallons)	Gasoline Savings (million gallons)
2018	20	1,861	71
2030	58	5,412	352
2050	91	8,453	570

(2) Upstream (Fuel Production and Distribution)

Upstream GHG emission reductions associated with the production and distribution of fuel were projected using emission factors from DOE's "Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation" (GREET1.8) model, with some modifications consistent with the Light-Duty Greenhouse Gas rulemaking. More information regarding these modifications can be found in the draft RIA Chapter 5. These estimates include both international and domestic emission reductions, since reductions in foreign exports of finished gasoline and/or crude would make up a significant share of the fuel savings resulting from the GHG standards. Thus, significant portions of the upstream GHG emission reductions will occur outside of the United States; a breakdown and discussion of projected international versus domestic reductions is included in the draft RIA Chapter 5. GHG emission reductions from upstream sources can be found in Table VI–6.

[208] Renewable Fuels Standards assumptions of 115,000 BTU/gallon gasoline (E0) and 76,330 BTU/gallon ethanol (E100) weighted 90% and 10%, respectively, and converted to kJ at 1.055 kJ/BTU.

[209] MOVES2004 Energy and Emission Inputs. EPA420–P–05–003, March 2005. *http://www.epa.gov/otaq/models/ngm/420p05003.pdf.*

Table VI-6: Annual Upstream GHG Emissions Reductions in 2018, 2030, and 2050

	CO_2 (MMT)	CH_4 (MMT CO_2eq)	N_2O (MMT CO_2eq)	Total GHG (MMT CO_2eq)
2018	4.5	0.8	0.02	5.3
2030	11.8	1.8	0.06	13.7
2050	16.7	2.6	0.08	19.3

(3) HFC Emissions

Based on projected HFC emission reductions due to the proposed AC leakage standards, EPA estimates the HFC reductions to be 118,885 metric tons of CO_2eq in 2018, 355,576 metric tons of CO_2eq emissions in 2030 and 417,584 metric tons CO_2eq in 2050, as detailed in draft RIA Chapter 5.3.4.

(4) Total (Upstream + Downstream + HFC)

Table VI–7 combines downstream results from Table VI–5, upstream results Table VI–6, and HFC results to show total GHG reductions for calendar years 2018, 2030, and 2050.

Table VI-7: Annual Total GHG Emissions Reductions in 2018, 2030, and 2050

	GHG Reductions (MMT CO_2eq)
2018	25
2030	72
2050	110

D. Overview of Climate Change Impacts From GHG Emissions

Once emitted, GHGs that are the subject of this regulation can remain in the atmosphere for decades to centuries, 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 and agricultural activities. Transportation activities, in aggregate, are the second largest contributor to total U.S. GHG emissions (27 percent) despite a decline in emissions from this sector during 2008.[210]

This section provides a summary of observed and projected changes in GHG emissions and associated climate change impacts. The source document for the section below is the Technical Support Document (TSD)[211] for EPA's Endangerment and Cause or Contribute Findings Under the Clean Air Act (74 FR 66496, December 15, 2009). Below is the Executive Summary of the TSD which provides technical support for the endangerment and cause or contribute analyses concerning GHG emissions under section 202(a) of the CAA. The TSD reviews observed and projected changes in climate based on current and projected atmospheric GHG concentrations and emissions, as well as the related impacts and risks from climate change that are projected in the absence of GHG mitigation actions, including this proposal and other U.S. and global actions. The TSD was updated and revised based on expert technical review and public comment as part of EPA's rulemaking process for the final Endangerment Findings. The key findings synthesized here and the information throughout the TSD are primarily drawn from the assessment reports of the Intergovernmental Panel on Climate Change (IPCC), the U.S. Climate Change Science Program (CCSP), the U.S. Global Change Research Program (USGCRP), and NRC.[212]

In May 2010, the NRC published its comprehensive assessment, "Advancing the Science of Climate Change."[213] It concluded that "climate change is occurring, is caused largely by human activities, and poses significant risks for—and in many cases is already affecting—a broad range of human and natural systems." Furthermore, the NRC stated that this conclusion is based on findings that are "consistent with the conclusions of recent assessments by the U.S. Global Change Research Program, the Intergovernmental Panel on Climate Change's Fourth Assessment Report, and other assessments of the state of scientific knowledge on climate change." These are the same assessments that served as the primary scientific references underlying the Administrator's Endangerment Finding. Importantly, this recent NRC assessment represents another independent and critical inquiry of the state of climate change science, separate and apart from the previous IPCC and USGCRP assessments. The NRC assessment is a clear affirmation that the scientific underpinnings of the Administrator's Endangerment Finding are robust, credible, and appropriately characterized by EPA.

(1) Observed Trends in Greenhouse Gas Emissions and Concentrations

The primary long-lived GHGs directly emitted by human activities include CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6. Greenhouse gases have a warming effect by trapping heat in the atmosphere that would otherwise escape to space. In 2007, U.S. GHG emissions were 7,150

[210] U.S. EPA (2010) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007. EPA–430–R–10–006, Washington, DC.

[211] *See* Endangerment TSD, Note 9 above.

[212] 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–2009–0171–11645.

[213] National Research Council (NRC) (2010). Advancing the Science of Climate Change. National Academy Press. Washington, DC.

teragrams[214] of CO_2 equivalent[215] ($TgCO_2eq$). The dominant gas emitted is CO_2, mostly from fossil fuel combustion. Methane is the second largest component of U.S. emissions, followed by N2O and the fluorinated gases (HFCs, PFCs, and SF6). Electricity generation is the largest emitting sector (34% of total U.S. GHG emissions), followed by transportation (27%) and industry (19%).

Transportation sources under section 202(a)[216] of the CAA (passenger cars, light-duty trucks, other trucks and buses, motorcycles, and passenger cooling) emitted 1,649 $TgCO_2eq$ in 2007, representing 23% of total U.S. GHG emissions. U.S. transportation sources under section 202(a) made up 4.3% of total global GHG emissions in 2005,[217] which, in addition to the United States as a whole, ranked only behind total GHG emissions from China, Russia, and India but ahead of Japan, Brazil, Germany, and the rest of the world's countries. In 2005, total U.S. GHG emissions were responsible for 18% of global emissions, ranking only behind China, which was responsible for 19% of global GHG emissions. The scope of this proposal focuses on GHG emissions under section 202(a) from heavy-duty source categories (*see* Section V).

The global atmospheric CO_2 concentration has increased about 38% from pre-industrial levels to 2009, and almost all of the increase is due to anthropogenic emissions. The global atmospheric concentration of CH_4 has increased by 149% since pre-industrial levels (through 2007); and the N_2O concentration has increased by 23% (through 2007). The observed concentration increase in these gases can also be attributed primarily to anthropogenic emissions. The industrial fluorinated gases, HFCs, PFCs, and SF_6, have relatively low atmospheric concentrations but the total radiative forcing due to these gases is increasing rapidly; these gases are almost entirely anthropogenic in origin.

Historic data show that current atmospheric concentrations of the two most important directly emitted, long-lived GHGs (CO_2 and CH_4) are well above the natural range of atmospheric concentrations compared to at least the last 650,000 years. Atmospheric GHG concentrations have been increasing because anthropogenic emissions have been outpacing the rate at which GHGs are removed from the atmosphere by natural processes over timescales of decades to centuries.

(2) Observed Effects Associated With Global Elevated Concentrations of GHGs

Greenhouse gases, at current (and projected) atmospheric concentrations, remain well below published exposure thresholds for any direct adverse health effects and are not expected to pose exposure risks (*i.e.,* breathing/inhalation).

The global average net effect of the increase in atmospheric GHG concentrations, plus other human activities (*e.g.,* land-use change and aerosol emissions), on the global energy balance since 1750 has been one of warming. This total net heating effect, referred to as forcing, is estimated to be +1.6 (+0.6 to +2.4) watts per square meter (W/m^2), with much of the range surrounding this estimate due to uncertainties about the cooling and warming effects of aerosols. However, as aerosol forcing has more regional variability than the well-mixed, long-lived GHGs, the global average might not capture some regional effects. The combined radiative forcing due to the cumulative (*i.e.,* 1750 to 2005) increase in atmospheric concentrations of CO_2, CH_4, and N_2O is estimated to be +2.30 (+2.07 to +2.53) W/m^2. The rate of increase in positive radiative forcing due to these three GHGs during the industrial era is very likely to have been unprecedented in more than 10,000 years.

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Global mean surface temperatures have risen by 1.3 ± 0.32 °F (0.74 °C ± 0.18 °C) over the last 100 years. Eight of the 10 warmest years on record have occurred since 2001. Global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries.

Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations. Climate model simulations suggest natural forcing alone (*i.e.,* changes in solar irradiance) cannot explain the observed warming.

U.S. temperatures also warmed during the 20th and into the 21st century; temperatures are now approximately 1.3 °F (0.7 °C) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. Both the IPCC[218] and the CCSP reports attributed recent North American warming to elevated GHG concentrations. In the CCSP (2008) report,[219] the authors find that for North America, "more than half of this warming [for the period 1951–2006] is likely the result of human-caused greenhouse gas forcing of climate change."

Observations show that changes are occurring in the amount, intensity, frequency and type of precipitation. Over the contiguous United States, total annual precipitation increased by 6.1% from 1901 to 2008. It is likely that there have been increases in the number of heavy precipitation events within many land regions, even in those where there has been a reduction in total precipitation amount, consistent with a warming climate.

There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate. It is not clear whether the increasing rate of sea level rise is a reflection of short-term variability or an increase in the longer-term trend. Nearly all of the Atlantic Ocean shows sea level rise during the last 50 years with the rate of rise reaching a maximum (over 2 millimeters [mm] per year) in a band along the U.S. east coast running east-northeast.

Satellite data since 1979 show that annual average Arctic sea ice extent has shrunk by 4.1% per decade. The size and speed of recent Arctic summer sea ice loss is highly anomalous relative to the previous few thousands of years.

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[214] One teragram (Tg) = 1 million metric tons. 1 metric ton = 1,000 kilograms = 1.102 short tons = 2,205 pounds.

[215] Long-lived GHGs are compared and summed together on a CO_2-equivalent basis by multiplying each gas by its global warming potential (GWP), as estimated by IPCC. In accordance with United Nations Framework Convention on Climate Change (UNFCCC) reporting procedures, the U.S. quantifies GHG emissions using the 100-year timeframe values for GWPs established in the IPCC Second Assessment Report.

[216] Source categories under Section 202(a) of the CAA are a subset of source categories considered in the transportation sector and do not include emissions from non-highway sources such as boats, rail, aircraft, agricultural equipment, construction/mining equipment, and other off-road equipment.

[217] More recent emission data are available for the United States and other individual countries, but 2005 is the most recent year for which data for all countries and all gases are available.

[218] Hegerl, G.C. *et al.* (2007) Understanding and Attributing Climate Change. In: *Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[219] CCSP (2008) *Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Randall Dole, Martin Hoerling, and Siegfried Schubert (eds.)]. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC, 156 pp.

Widespread changes in extreme temperatures have been observed in the last 50 years across all world regions, including the United States. Cold days, cold nights, and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent.

Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. However, directly attributing specific regional changes in climate to emissions of GHGs from human activities is difficult, especially for precipitation.

Ocean CO_2 uptake has lowered the average ocean pH (increased acidity) level by approximately 0.1 since 1750. Consequences for marine ecosystems can include reduced calcification by shell-forming organisms, and in the longer term, the dissolution of carbonate sediments.

Observations show that climate change is currently affecting U.S. physical and biological systems in significant ways. The consistency of these observed changes in physical and biological systems and the observed significant warming likely cannot be explained entirely due to natural variability or other confounding non-climate factors.

(3) Projections of Future Climate Change With Continued Increases in Elevated GHG Concentrations

Most future scenarios that assume no explicit GHG mitigation actions (beyond those already enacted) project increasing global GHG emissions over the century, with climbing GHG concentrations. Carbon dioxide is expected to remain the dominant anthropogenic GHG over the course of the 21st century. The radiative forcing associated with the non-CO_2 GHGs is still significant and increasing over time.

Future warming over the course of the 21st century, even under scenarios of low-emission growth, is very likely to be greater than observed warming over the past century. According to climate model simulations summarized by the IPCC,[220] through about 2030, the global warming rate is affected little by the choice of different future emissions scenarios. By the end of the 21st century, projected average global warming (compared to average temperature around 1990) varies significantly depending on the emission scenario and climate sensitivity assumptions, ranging from 3.2 to 7.2 °F (1.8 to 4.0 °C), with an uncertainty range of 2.0 to 11.5 °F (1.1 to 6.4 °C).

All of the United States is very likely to warm during this century, and most areas of the United States are expected to warm by more than the global average. The largest warming is projected to occur in winter over northern parts of Alaska. In western, central and eastern regions of North America, the projected warming has less seasonal variation and is not as large, especially near the coast, consistent with less warming over the oceans.

It is very likely that heat waves will become more intense, more frequent, and longer lasting in a future warm climate, whereas cold episodes are projected to decrease significantly.

Increases in the amount of precipitation are very likely in higher latitudes, while decreases are likely in most subtropical latitudes and the southwestern United States, continuing observed patterns. The mid-continental area is expected to experience drying during summer, indicating a greater risk of drought.

Intensity of precipitation events is projected to increase in the United States and other regions of the world. More intense precipitation is expected to increase the risk of flooding and result in greater runoff and erosion that has the potential for adverse water quality effects.

It is likely that hurricanes will become more intense, with stronger peak winds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures. Frequency changes in hurricanes are currently too uncertain for confident projections.

By the end of the century, global average sea level is projected by IPCC[221] to rise between 7.1 and 23 inches (18 and 59 centimeter [cm]), relative to around 1990, in the absence of increased dynamic ice sheet loss. Recent rapid changes at the edges of the Greenland and West Antarctic ice sheets show acceleration of flow and thinning. While an understanding of these ice sheet processes is incomplete, their inclusion in models would likely lead to increased sea level projections for the end of the 21st century.

Sea ice extent is projected to shrink in the Arctic under all IPCC emissions scenarios.

(4) Projected Risks and Impacts Associated With Future Climate Change

Risk to society, ecosystems, and many natural Earth processes increase with increases in both the rate and magnitude of climate change. Climate warming may increase the possibility of large, abrupt regional or global climatic events (*e.g.,* disintegration of the Greenland Ice Sheet or collapse of the West Antarctic Ice Sheet). The partial deglaciation of Greenland (and possibly West Antarctica) could be triggered by a sustained temperature increase of 2 to 7 °F (1 to 4° C) above 1990 levels. Such warming would cause a 13 to 20 feet (4 to 6 meter) rise in sea level, which would occur over a time period of centuries to millennia.

The CCSP[222] reports that climate change has the potential to accentuate the disparities already evident in the American health care system, as many of the expected health effects are likely to fall disproportionately on the poor, the elderly, the disabled, and the uninsured. The IPCC[223] states with very high confidence that climate change impacts on human health in U.S. cities will be compounded by population growth and an aging population.

Severe heat waves are projected to intensify in magnitude and duration over the portions of the United States where these events already occur, with potential increases in mortality and morbidity, especially among the elderly, young, and frail.

Some reduction in the risk of death related to extreme cold is expected. It is not clear whether reduced mortality from cold will be greater or less than increased heat-related mortality in the United States due to climate change.

[220] Meehl, G.A. *et al.* (2007) Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[221] IPCC (2007) Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[222] Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson (2008) Effects of Global Change on Human Health. In: *Analyses of the effects of global change on human health and welfare and human systems.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, pp. 2–1 to 2–78.

[223] Field, C.B. *et al.* (2007) North America. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Increases in regional ozone pollution relative to ozone levels without climate change are expected due to higher temperatures and weaker circulation in the United States and other world cities relative to air quality levels without climate change. Climate change is expected to increase regional ozone pollution, with associated risks in respiratory illnesses and premature death. In addition to human health effects, tropospheric ozone has significant adverse effects on crop yields, pasture and forest growth, and species composition. The directional effect of climate change on ambient particulate matter levels remains uncertain.

Within settlements experiencing 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. Thus, the potential impacts of climate change raise environmental justice issues.

The CCSP [224] concludes that, with increased CO_2 and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable. Furthermore, the marketable yield of many horticultural crops (*e.g.*, tomatoes, onions, fruits) is very likely to be more sensitive to climate change than grain and oilseed crops.

Higher temperatures will very likely reduce livestock production during the summer season in some areas, but these losses will very likely be partially offset by warmer temperatures during the winter season.

Cold-water fisheries will likely be negatively affected; warm-water fisheries will generally benefit; and the results for cool-water fisheries will be mixed, with gains in the northern and losses in the southern portions of ranges.

Climate change has very likely increased the size and number of forest fires, insect outbreaks, and tree mortality in the interior West, the Southwest, and Alaska, and will continue to do so. Over North America, forest growth and productivity have been observed to increase since the middle of the 20th century, in part due to observed climate change. Rising CO_2 will very likely increase photosynthesis for forests, but the increased photosynthesis will likely only increase wood production in young forests on fertile soils. The combined effects of expected increased temperature, CO_2, nitrogen deposition, ozone, and forest disturbance on soil processes and soil carbon storage remain unclear.

Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution. Sea level is rising along much of the U.S. coast, and the rate of change will very likely increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding, and shoreline erosion. Storm impacts are likely to be more severe, especially along the Gulf and Atlantic coasts. Salt marshes, other coastal habitats, and dependent species are threatened by sea level rise, fixed structures blocking landward migration, and changes in vegetation. Population growth and rising value of infrastructure in coastal areas increases vulnerability to climate variability and future climate change.

Climate change will likely further constrain already over-allocated water resources in some regions of the United States, increasing competition among agricultural, municipal, industrial, and ecological uses. Although water management practices in the United States are generally advanced, particularly in the West, the reliance on past conditions as the basis for current and future planning may no longer be appropriate, as climate change increasingly creates conditions well outside of historical observations. Rising temperatures will diminish snowpack and increase evaporation, affecting seasonal availability of water. In the Great Lakes and major river systems, lower water levels are likely to exacerbate challenges relating to water quality, navigation, recreation, hydropower generation, water transfers, and binational relationships. Decreased water supply and lower water levels are likely to exacerbate challenges relating to aquatic navigation in the United States.

Higher water temperatures, increased precipitation intensity, and longer periods of low flows will exacerbate many forms of water pollution, potentially making attainment of water quality goals more difficult. As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to warmer water. In the long term, warmer water and changing flow may result in deterioration of aquatic ecosystems.

Ocean acidification is projected to continue, resulting in the reduced biological production of marine calcifiers, including corals.

Climate change is likely to affect U.S. energy use and energy production and physical and institutional infrastructures. It will also likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements, particularly in Alaska where indigenous communities are facing major environmental and cultural impacts. The U.S. energy sector, which relies heavily on water for hydropower and cooling capacity, may be adversely impacted by changes to water supply and quality in reservoirs and other water bodies. Water infrastructure, including drinking water and wastewater treatment plants, and sewer and stormwater management systems, will be at greater risk of flooding, sea level rise and storm surge, low flows, and other factors that could impair performance.

Disturbances such as wildfires and insect outbreaks are increasing in the United States and are likely to intensify in a warmer future with warmer winters, drier soils, and longer growing seasons. Although recent climate trends have increased vegetation growth, continuing increases in disturbances are likely to limit carbon storage, facilitate invasive species, and disrupt ecosystem services.

Over the 21st century, changes in climate will cause species to shift north and to higher elevations and fundamentally rearrange U.S. ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will alter ecosystem structure, function, and services.

(5) Present and Projected U.S. Regional Climate Change Impacts

Climate change impacts will vary in nature and magnitude across different regions of the United States.

Sustained high summer temperatures, heat waves, and declining air quality are projected in the Northeast,[225]

[224] Backlund, P., A. Janetos, D.S. Schimel, J. Hatfield, M.G. Ryan, S.R. Archer, and D. Lettenmaier (2008) Executive Summary. In: *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC., USA, 362 pp.

[225] Northeast includes West Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine.

Southeast,[226] Southwest,[227] and Midwest.[228] Projected climate change would continue to cause loss of sea ice, glacier retreat, permafrost thawing, and coastal erosion in Alaska.

Reduced snowpack, earlier spring snowmelt, and increased likelihood of seasonal summer droughts are projected in the Northeast, Northwest,[229] and Alaska. More severe, sustained droughts and water scarcity are projected in the Southeast, Great Plains,[230] and Southwest.

The Southeast, Midwest, and Northwest in particular are expected to be impacted by an increased frequency of heavy downpours and greater flood risk.

Ecosystems of the Southeast, Midwest, Great Plains, Southwest, Northwest, and Alaska are expected to experience altered distribution of native species (including local extinctions), more frequent and intense wildfires, and an increase in insect pest outbreaks and invasive species.

Sea level rise is expected to increase storm surge height and strength, flooding, erosion, and wetland loss along the coasts, particularly in the Northeast, Southeast, and islands.

Warmer water temperatures and ocean acidification are expected to degrade important aquatic resources of islands and coasts such as coral reefs and fisheries.

A longer growing season, low levels of warming, and fertilization effects of carbon dioxide may benefit certain crop species and forests, particularly in the Northeast and Alaska. Projected summer rainfall increases in the Pacific islands may augment limited freshwater supplies. Cold-related mortality is projected to decrease, especially in the Southeast. In the Midwest in particular, heating oil demand and snow-related traffic accidents are expected to decrease.

Climate change impacts in certain regions of the world may exacerbate problems that raise humanitarian, trade, and national security issues for the United States. The IPCC[231] identifies the most vulnerable world regions as the Arctic, because of the effects of high rates of projected warming on natural systems; Africa, especially the sub-Saharan region, because of current low adaptive capacity as well as climate change; small islands, due to high exposure of population and infrastructure to risk of sea level rise and increased storm surge; and Asian mega-deltas, such as the Ganges-Brahmaputra and the Zhujiang, due to large populations and high exposure to sea level rise, storm surge and river flooding. Climate change has been described as a potential threat multiplier with regard to national security issues.

E. Changes in Atmospheric CO_2 Concentrations, Global Mean Temperature, Sea Level Rise, and Ocean pH Associated with the Proposal's GHG Emissions Reductions

EPA examined[232] the reductions in CO_2 and other GHGs associated with this proposal and analyzed the projected effects on atmospheric CO_2 concentrations, global mean surface temperature, sea level rise, and ocean pH which are common variables used as indicators of climate change. The analysis projects that the preferred alternative of this proposal will reduce atmospheric concentrations of CO_2, global climate warming and sea level rise. Although the projected reductions and improvements are small in overall magnitude by themselves, they are quantifiable and would contribute to reducing the risks associated with climate change.

EPA determines that the projected reductions in atmospheric CO_2, global mean temperature and sea level rise are meaningful in the context of this proposal. In addition, EPA has conducted an analysis to evaluate the projected changes in ocean pH in the context of the changes in emissions from this proposal. The results for projected atmospheric CO_2 concentrations are estimated to be reduced by 0.693 to 0.784 part per million by volume (ppmv) (average of 0.732 ppmv), global mean temperature is estimated to be reduced by 0.002 to 0.004°C, sea-level rise is projected to be reduced by approximately 0.012–0.048 cm based on a range of climate sensitivities, and ocean pH will increase by 0.0003 pH units by 2100.

(1) Estimated Projected Reductions in Atmospheric CO_2 Concentration, Global Mean Surface Temperatures, Sea Level Rise, and Ocean pH

EPA estimated changes in the atmospheric CO_2 concentration, global mean temperature, and sea level rise out to 2100 resulting from the emissions reductions in this proposal using the GCAM (Global Change Assessment Model, formerly MiniCAM), integrated assessment model[233] coupled with the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC, version 5.3v2).[234] GCAM was used to create the globally and temporally consistent set of climate relevant variables required for running MAGICC. MAGICC was then used to estimate the projected change in these variables over time. Given the magnitude of the estimated emissions reductions associated with the rule, a simple climate model such as MAGICC is reasonable for estimating the atmospheric and climate response. This widely-used, peer reviewed modeling tool was also used to project temperature and sea level rise under different emissions scenarios in the Third and Fourth Assessments of the IPCC.

The integrated impact of the following pollutant and greenhouse gas emissions changes are considered: CO_2, CH_4, N_2O, NO_X, CO_2 and SO2, and volatile organic compounds (VOC). For CO, SO_2, and NO_X, emissions reductions were estimated for 2018, 2030, and 2050 (provided in Section VII.A). For CO_2, CH_4, and N_2O an annual time-series of

[226] Southeast includes Kentucky, Virginia, Arkansas, Tennessee, North Carolina, South Carolina, southeast Texas, Louisiana, Mississippi, Alabama, Georgia, and Florida.

[227] Southwest includes California, Nevada, Utah, western Colorado, Arizona, New Mexico (except the extreme eastern section), and southwest Texas.

[228] The Midwest includes Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio, and Missouri.

[229] The Northwest includes Washington, Idaho, western Montana, and Oregon.

[230] The Great Plains includes central and eastern Montana, North Dakota, South Dakota, Wyoming, Nebraska, eastern Colorado, Nebraska, Kansas, extreme eastern New Mexico, central Texas, and Oklahoma

[231] Parry, M.L. *et al.* (2007) Technical Summary. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)], Cambridge University Press, Cambridge, United Kingdom, pp. 23S78.

[232] Using the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) 5.3v2, *http://www.cgd.ucar.edu/cas/wigley/magicc/*), EPA estimated the effects of this proposal's greenhouse gas emissions reductions on global mean temperature and sea level. Please refer to Chapter 8.4 of the RIA for additional information.

[233] 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 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.

Brenkert A, S. Smith, S. Kim, and H. Pitcher, 2003: Model Documentation for the MiniCAM. PNNL–14337, Pacific Northwest National Laboratory, Richland, Washington.

[234] Wigley, T.M.L. 2008. MAGICC 5.3.v2 User Manual. *UCAR*—Climate and Global Dynamics Division, Boulder, Colorado. *http://www.cgd.ucar.edu/cas/wigley/magicc/.*

(upstream + downstream) emissions reductions estimated from the proposal were input directly. The GHG emissions reductions, from Section VI.C, were applied as net reductions to a global reference case (or baseline) emissions scenario in GCAM to generate an emissions scenario specific to this proposal. EPA linearly scaled emissions reductions between a zero input value in 2013 and the value supplied for 2018 to produce the reductions for 2014–2018. A similar scaling was used for 2019–2029 and 2031–2050. The emissions reductions past 2050 were scaled with total U.S. road transportation fuel consumption from the GCAM reference scenario. Road transport fuel consumption past 2050 does not change significantly and thus emissions reductions remain relatively constant from 2050 through 2100. Specific details about the reference case scenario and how the emissions reductions were applied to generate the scenario can be found in the proposal's RIA, Chapter 8.4.

MAGICC is a global model and is primarily concerned with climate, therefore the impact of short-lived climate forcing agents (*e.g.*, O_3) are not explicitly simulated as in regional air quality models. While many precursors related to short-lived climate forcers such as ozone are considered, MAGICC simulates the longer term effect on climate from long-lived GHGs. The impacts to ground-level ozone and other non-GHGs are discussed in Section VII of this proposal and the draft RIA Chapter 8.2. Some aerosols, such as black carbon, cause a positive forcing or warming effect by absorbing incoming solar radiation. There remain some significant scientific uncertainties about black carbon's total climate effect,[235] as well as concerns about how to treat the short-lived black carbon emissions alongside the long-lived, well-mixed greenhouse gases in a common framework (*e.g.*, what are the appropriate metrics to compare the warming and/or climate effects of the different substances, given that, unlike greenhouse gases, the magnitude of aerosol effects can vary immensely with location and season of emissions). Further, estimates of the direct radiative forcing of individual species are less certain than the total direct aerosol radiative forcing.

There is no single accepted methodology for transforming black carbon emissions into temperature change or CO_2eq emissions. The interaction of black carbon (and other co-emitted aerosol species) with clouds is especially poorly quantified, and this factor is key to any attempt to estimate the net climate impacts of black carbon. While black carbon is likely to be an important contributor to climate change, it would be premature to include quantification of black carbon climate impacts in an analysis of the proposed standards at this time.

Changes in atmospheric CO_2 concentration, global mean temperature, and sea level rise for both the reference case and the emissions scenarios associated with this proposal were computed using MAGICC. To calculate the reductions in the atmospheric CO_2 concentrations as well as in temperature and sea level resulting from this proposal, the output from the policy scenario associated with the preferred approach of this proposal was subtracted from an existing Global Change Assessment Model (GCAM, formerly MiniCAM) reference emission scenario. To capture some key uncertainties in the climate system with the MAGICC model, changes in atmospheric CO_2, global mean temperature and sea level rise were projected across the most current IPCC range of climate sensitivities which ranges from 1.5 °C to 6.0 °C.[236] This range reflects the uncertainty for equilibrium climate sensitivity for how much global mean temperature would rise if the concentration of carbon dioxide in the atmosphere were to double. The information for this range come from constraints from past climate change on various time scales, and the spread of results for climate sensitivity from ensembles of models.[237] Details about this modeling analysis can be found in the draft RIA Chapter 8.4.

The results of this modeling, summarized in Table VI–8, show small but quantifiable reductions in atmospheric CO_2 concentrations, projected global mean temperature and sea level resulting from this proposal, across all climate sensitivities. As a result of the emission reductions from the proposed standards for this proposal, the atmospheric CO_2 concentration is projected to be reduced by an average of 0.732 ppmv, the global mean temperature is projected to be reduced by approximately 0.002–0.004 °C by 2100, and global mean sea level rise is projected to be reduced by approximately 0.012–0.050 cm by 2100. The range of reductions in global mean temperature and sea level rise is larger because CO_2 concentrations are not tightly coupled to climate sensitivity, whereas the magnitude of temperature change response to CO_2 changes (and therefore sea level rise) is tightly coupled to climate sensitivity in the MAGICC model.

[235] The range of uncertainty in the current magnitude of black carbon's climate forcing effect is evidenced by the ranges presented by the IPCC Fourth Assessment Report (2007) and the more recent study by Ramanathan, V. and Carmichael, G. (2008) Global and regional climate changes due to black carbon. Nature Geoscience, 1(4): 221–227.

[236] In IPCC reports, equilibrium climate sensitivity refers to the equilibrium change in the annual mean global surface temperature following a doubling of the atmospheric equivalent carbon dioxide concentration. The IPCC states that climate sensitivity is "likely" to be in the range of 2 °C to 4.5 °C, "very unlikely" to be less than 1.5 °C, and "values substantially higher than 4.5° C cannot be excluded." IPCC WGI, 2007, *Climate Change 2007—The Physical Science Basis*, Contribution of Working Group I to the Fourth Assessment Report of the IPCC, *http://www.ipcc.ch/*.

[237] Meehl, G.A. et al. (2007) Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Table VI-8: Impact of GHG Emissions Reductions on Projected Changes in Global Climate Associated with the Proposal (Based on a range of climate sensitivities from 1.5-6°C)

Variable	Units	Year	Projected Change
Atmospheric CO_2 Concentration	ppmv	2100	-0.693 to -0.784
Global Mean Surface Temperature	°C	2100	-0.002 to -0.004
Sea Level Rise	cm	2100	-0.012 to -0.048
Ocean pH	pH units	2100	0.0003[a]

Notes:

[a] The value for projected change in ocean pH is based on a climate sensitivity of 3.0.

The reductions are small relative to the IPCC's 2100 "best estimates"[238] for global mean temperature increases (1.1—6.4 °C) and sea level rise (0.18–0.59m) for all global GHG emissions sources for a range of emissions scenarios.[239] These "best estimates" are assessed from a hierarchy of models that encompass a simple climate model, several Earth Models of Intermediate Complexity, and a large number of Atmosphere-Ocean Global Circulation Models and are based on the six major scenarios described in the Special Report on Emissions Scenarios, not including dynamical ice sheet behavior that would lead to an increase in sea level rise. Further discussion of EPA's modeling analysis is found in the draft RIA, Chapter 8.

EPA used the Program CO2SYS,[240] version 1.05 to estimate projected changes in ocean pH for tropical waters based on the atmospheric CO_2 concentration change (reduction) resulting from this proposal. The program performs calculations relating parameters of the CO_2 system in seawater. EPA used the program to calculate ocean pH as a function of atmospheric CO_2 concentrations, among other specified input conditions. Based on the projected atmospheric CO_2 concentration reductions (0.731 ppmv by 2100 for a climate sensitivity of 3.0) that would result from this proposal, the program calculates an increase in ocean pH of 0.0003 pH units. Thus, this analysis indicates the projected decrease in atmospheric CO_2 concentrations from the preferred approach associated with this proposal would result in an increase in ocean pH. For additional validation, results were generated from the atmospheric CO_2 concentration change for each climate sensitivity case (1.5 to 6.0) and using different known constants from the literature. A comprehensive discussion of the modeling analysis associated with ocean pH is provided in the draft RIA, Chapter 8.

(2) Proposal's Effect on Climate

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 essentially permanent climate change on centennial time scales. Reductions in emissions in the near-term are important in determining long-term climate stabilization and associated impacts experienced not just over the next decades but in the coming centuries and millennia.[241] Though the magnitude of the avoided climate change projected here is small, these reductions would represent a reduction in the adverse risks associated with climate change (though these risks were not formally estimated for this proposal) across a range of equilibrium climate sensitivities.

EPA's analysis of the proposal's impact on global climate conditions is intended to quantify these potential reductions using the best available science. While EPA's modeling results of the effect of this proposal alone show small differences in climate effects (CO_2 concentration, temperature, sea-level rise, ocean pH), when expressed in terms of global climate endpoints and global GHG emissions, yield results that are repeatable and consistent within the modeling frameworks used.

VII. How Would This Proposal Impact Non-GHG Emissions and Their Associated Effects?

A. Emissions Inventory Impacts

(1) Upstream Impacts of the Program

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. These projected upstream emission impacts on criteria pollutants are summarized in Table VII–1. Table VII–2 shows the corresponding projected impacts on upstream air toxic emissions in 2030.

[238] IPCC's "best estimates" at the end of the 21st century from Table TS.6 in the Technical Summary: Contribution of Working Group I (Solomon *et al.*, 2007).

[239] IPCC (2007) Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[240] Lewis, E., and D. W. R. Wallace. 1998. Program Developed for CO_2 System Calculations. ORNL/CDIAC–105. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee.

[241] National Research Council (NRC) (2010). Climate Stabilization Targets. Committee on Stabilization Targets for Atmospheric Greenhouse Gas Concentrations; Board on Atmospheric Sciences and Climate, Division of Earth and Life Sciences, National Academy Press. Washington, DC.

Table VII-1: Overall estimated upstream impacts on criteria pollutants for calendar years 2018, 2030, and 2050 (short tons)

Calendar Year	NO_X	VOC	CO	$PM_{2.5}$
2018	-5,683	-1,679	-1,945	-852
2030	-9,623	-4,419	-3,214	-1,331
2050	-14,692	-6,880	-4,942	-2,034

Table VII-2: Overall estimated upstream impacts on air toxics for calendar years 2018, 2030, and 2050 (short tons)

Calendar Year	Benzene	1,3-butadiene	Formaldehyde	Acetaldehyde	Acrolein
2018	-11	-1	-10	-2	0
2030	-19	-1	-25	-4	-1
2050	-30	-1	-36	-5	-1

To project these impacts, EPA 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. For this analysis EPA estimated that 50 percent of fuel savings is attributable to domestic finished gasoline and diesel and that 90 percent of this gasoline and diesel originated from imported crude. Emission factors for most upstream emission sources are based on the GREET1.8 model, developed by DOE's Argonne National Laboratory but in some cases the GREET values were modified or updated by EPA to be consistent with the National Emission Inventory. These updates are consistent with those used for the upstream analysis included in the Light-Duty GHG rulemaking. More information on the development of the emission factors used in this analysis can be found in draft RIA Chapter 5.

(2) Downstream Impacts of the Program

While these proposed rules do not regulate non-GHG pollutants, EPA expects reductions in downstream emissions of most non-GHG pollutants. These pollutants include NO_X, SO_2, CO, and HC. The primary reason for this is the improvements in road load (aerodynamics and tire rolling resistance) under the proposal. Another reason is that emissions from certain pollutants (*e.g.,* SO_2) are proportional to fuel consumption. For vehicle types not affected by road load improvements, non-GHG emissions may increase very slightly due to VMT rebound. EPA also anticipates the use of APUs in combination tractors for GHG reduction purposes during extended idling. These units exhibit different non-GHG emissions characteristics compared to the on-road engines they would replace during extended idling. EPA used MOVES to determine non-GHG emissions inventories for baseline and control cases. Further information about the MOVES analysis is available in Section VI and RIA Chapter 5. The improvements in road load, use of APUs, and VMT rebound were included in the MOVES runs and post-processing. Table VII–3 summarizes the downstream criteria pollutant impacts of this proposal. Most of the impacts shown are through projected increased APU use. Because APUs are required to meet much less stringent $PM_{2.5}$ standards than on-road engines, the projected widespread use of APUs leads to higher $PM_{2.5}$. Table VII–4 summarizes the downstream air toxics impacts of this proposal.

Table VII-3: Overall Estimated Downstream Impacts on Criteria Pollutants (short tons)

Calendar Year	Downstream NO_X	Downstream VOC	Downstream CO	Downstream $PM_{2.5}$ [a]
2018	-96,764	-10,404	-23,329	714
2030	-231,631	-25,121	-53,709	1,694
2050	-326,491	-35,648	-75,083	2,416

Note:
[a] Positive number means emissions would increase from baseline to control case. $PM_{2.5}$ from tire wear and brake wear is included.

Table VII-4: Overall Estimated Downstream Impacts on Air Toxics (short tons)

Calendar Year	Benzene	1,3-butadiene	Formaldehyde	Acetaldehyde	Acrolein
2018	-143	0	-2,607	-796	-109
2030	-339	0	-6,227	-1,899	-261
2050	-477	1	-8,774	-2,676	-368

(3) Total Impacts of the Program

As shown in Table VII–5 and Table VII–6, the agencies estimate that this program would result in reductions of NO_X, VOC, CO, SO_X, and air toxics. For NO_X, VOC, and CO, much of the net reductions are realized through the use of APUs, which emit these pollutants at a lower rate than on-road engines during extended idle operation. Additional reductions are achieved in all pollutants through reduced road load (improved aerodynamics and tire rolling resistance), which reduces the amount of work required to travel a given distance. For SO_X, downstream emissions are roughly proportional to fuel consumption; therefore a decrease is seen in both upstream and downstream sources. The downstream increase in $PM_{2.5}$ due to APU use is mostly negated by upstream $PM_{2.5}$ reductions, though our calculations show a slight net increase in 2030 and 2050.[242]

Table VII-5: Overall Estimated Total Impacts (Upstream Plus Downstream) on Criteria Pollutants Results are shown in both short tons and percent change from baseline to control case.

CY	NO_X		VOC		CO		$PM_{2.5}$	
	short tons	%	short tons	%	short tons	%	short tons	%
2018	-102,447	-5.0%	-12,083	-4.0%	-25,274	-0.79%	-138	-0.17%
2030	-241,254	-19.6%	-29,540	-14.8%	-56,923	-2.13%	363	0.98%
2050	-341,183	-21.7%	-42,528	-17.0%	-80,025	-2.46%	382	0.80%

Table VII-6: Overall Estimated Total Impacts (Upstream Plus Downstream) Impacts on Air Toxics

CY	Benzene		1,3-butadiene		Formaldehyde		Acetaldehyde		Acrolein	
	short tons	%	short tons	%	short tons	%	short tons	%	short tons	%
2018	-154	-3.6	-1	-0.1	-2,617	-15.3	-798	-11.3	-109	-10.2
2030	-358	-13.0	-1	-0.1	-6,252	-44.0	-1,903	-37.8	-262	-37.7
2050	-507	-15.2	0	0.0	-8,810	-46.4	-2,681	-41.2	-369	-41.6

[242] Although the net impact is small when aggregated to 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. Impacts of the emissions changes will be included in the air quality modeling that will be completed for the final rulemaking.

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 heavy-duty vehicle standards.

(1) Particulate Matter

(a) Background

Particulate matter is a generic term for a broad class of chemically and physically diverse substances. It can be principally characterized as discrete particles that exist in the condensed (liquid or solid) phase spanning several orders of magnitude in size. Since 1987, EPA has delineated that subset of inhalable particles small enough to penetrate to the thoracic region (including the tracheobronchial and alveolar regions) of the respiratory tract (referred to as thoracic particles). Current National Ambient Air Quality Standards (NAAQS) use $PM_{2.5}$ as the indicator for fine particles (with $PM_{2.5}$ referring to particles with a nominal mean aerodynamic diameter less than or equal to 2.5 µm), and use PM_{10} as the indicator for purposes of regulating the coarse fraction of PM_{10} (referred to as thoracic coarse particles or coarse-fraction particles; generally including particles with a nominal mean aerodynamic diameter greater than 2.5 µm and less than or equal to 10 µm, or $PM_{10-2.5}$). Ultrafine particles are a subset of fine particles, generally less than 100 nanometers (0.1 µm) in aerodynamic diameter.

Fine particles are produced primarily by combustion processes and by transformations of gaseous emissions (*e.g.,* SO_X, NO_X, and 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 pollutants 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 series of adverse health effects. These health effects are discussed in detail in EPA's Integrated Science Assessment for Particulate Matter (ISA).[243] Further discussion of health effects associated with PM can also be found in the draft RIA for this proposal. The ISA summarizes evidence associated with $PM_{2.5}$, $PM_{10-2.5}$, and ultrafine particles.

The ISA concludes that health effects associated with short-term exposures (hours to days) to ambient $PM_{2.5}$ include mortality, cardiovascular effects, such as altered vasomotor function and hospital admissions and emergency department visits for ischemic heart disease and congestive heart failure, and respiratory effects, such as exacerbation of asthma symptoms in children and hospital admissions and emergency department visits for chronic obstructive pulmonary disease and respiratory infections.[244] The ISA notes that long-term exposure to $PM_{2.5}$ (months to years) is associated with the development/progression of cardiovascular disease, premature mortality, and respiratory effects, including reduced lung function growth, increased respiratory symptoms, and asthma development.[245] The ISA concludes that the currently available scientific evidence from epidemiologic, controlled human exposure, and toxicological studies supports a causal association between short- and long-term exposures to $PM_{2.5}$ and cardiovascular effects and mortality. Furthermore, the ISA concludes that the collective evidence supports likely causal associations between short- and long-term PM2.5 exposures and respiratory effects. The ISA also concludes that the scientific evidence is suggestive of a causal association for reproductive and developmental effects and cancer, mutagenicity, and genotoxicity and long-term exposure to $PM_{2.5}$.[246]

For $PM_{10-2.5}$, the ISA concludes that the current evidence is suggestive of a causal relationship between short-term exposures and cardiovascular effects, such as hospitalization for ischemic heart disease. There is also suggestive evidence of a causal relationship between short-term $PM_{10-2.5}$ exposure and mortality and respiratory effects. Data are inadequate to draw conclusions regarding the health effects associated with long-term exposure to $PM_{10-2.5}$.[247]

For ultrafine particles, the ISA concludes that there is suggestive evidence of a causal relationship between short-term exposures and cardiovascular effects, such as changes in heart rhythm and blood vessel function. It also concludes that there is suggestive evidence of association between short-term exposure to ultrafine particles and respiratory effects. Data are inadequate to draw conclusions regarding the health effects associated with long-term exposure to ultrafine particles.[248]

(2) Ozone

(a) Background

Ground-level ozone pollution is typically formed by the reaction of 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 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.

(b) Health Effects of Ozone

The health and welfare effects of ozone are well documented and are assessed in EPA's 2006 Air Quality Criteria Document and 2007 Staff Paper.[249] [250] People who are more susceptible to effects associated with exposure to ozone can include children, the elderly, and individuals with respiratory disease such as asthma. Those with greater exposures to ozone, for instance due to time spent outdoors (*e.g.,* children and outdoor workers), are of particular concern. Ozone can irritate the respiratory system, causing coughing, throat irritation, and breathing discomfort. Ozone can reduce

[243] U.S. EPA (2009) Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, Docket EPA–HQ–OAR–2010–0162.

[244] *See* U.S. EPA, 2009 Final PM ISA, Note 243, at Section 2.3.1.1.

[245] *See* U.S. EPA 2009 Final PM ISA, Note 243, at page 2–12, Sections 7.3.1.1 and 7.3.2.1.

[246] *See* U.S. EPA 2009 Final PM ISA, Note 243, at Section 2.3.2.

[247] *See* U.S. EPA 2009 Final PM ISA, Note 243, at Section 2.3.4, Table 2–6.

[248] *See* U.S. EPA 2009 Final PM ISA, Note 243, at Section 2.3.5, Table 2–6.

[249] U.S. EPA. (2006). Air Quality Criteria for Ozone and Related Photochemical Oxidants (Final). EPA/600/R–05/004aF–cF. Washington, DC: U.S. EPA. Docket EPA–HQ–OAR–2010–0162.

[250] U.S. EPA. (2007). Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper. EPA–452/R–07–003. Washington, DC, U.S. EPA. Docket EPA–HQ–OAR–2010–0162.

lung function and cause pulmonary inflammation in healthy individuals. Ozone can also aggravate asthma, leading to more asthma attacks that require medical attention and/or the use of additional medication. Thus, ambient ozone may cause both healthy and asthmatic individuals to limit their outdoor activities. In addition, there is suggestive evidence of a contribution of ozone to cardiovascular-related morbidity and highly suggestive evidence that short-term ozone exposure directly or indirectly contributes to non-accidental and cardiopulmonary-related mortality, but additional research is needed to clarify the underlying mechanisms causing these effects. In a recent report on the estimation of ozone-related premature mortality published by NRC, a panel of experts and reviewers concluded that short-term exposure to ambient ozone is likely to contribute to premature deaths and that ozone-related mortality should be included in estimates of the health benefits of reducing ozone exposure.[251] Animal toxicological evidence indicates that with repeated exposure, ozone can inflame and damage the lining of the lungs, which may lead to permanent changes in lung tissue and irreversible reductions in lung function. The respiratory effects observed in controlled human exposure studies and animal studies are coherent with the evidence from epidemiologic studies supporting a causal relationship between acute ambient ozone exposures and increased respiratory-related emergency room visits and hospitalizations in the warm season. In addition, there is suggestive evidence of a contribution of ozone to cardiovascular-related morbidity and non-accidental and cardiopulmonary mortality.

(3) Nitrogen Oxides and Sulfur 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. 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 NO_2 can dissolve in water droplets and further oxidize to form sulfuric and nitric acid which react with ammonia to form sulfates and nitrates, both of which are important components of ambient PM. The health effects of ambient PM are discussed in Section VII. B. (1) (b) of this preamble. NO_X and NMHC are the two major precursors of ozone. The health effects of ozone are covered in Section VII. B. (2)(b).

(b) Health Effects of NO_2

Information on the health effects of NO_2 can be found in the EPA Integrated Science Assessment (ISA) for Nitrogen Oxides.[252] The EPA has concluded that the findings of epidemiologic, controlled human exposure, and animal toxicological studies provide evidence that is sufficient to infer a likely causal relationship between respiratory effects and short-term NO_2 exposure. The ISA concludes that the strongest evidence for such a relationship comes from epidemiologic studies of respiratory effects including symptoms, emergency department visits, and hospital admissions. The ISA also draws two broad conclusions regarding airway responsiveness following NO_2 exposure. First, the ISA concludes 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 asthmatics to NO_2 concentrations as low as 0.26 ppm. In addition, small but significant increases in non-specific airway hyperresponsiveness were reported following 1-hour exposures of asthmatics to 0.1 ppm NO_2. Second, exposure to NO_2 has been found to enhance the inherent responsiveness of the airway to subsequent nonspecific challenges in controlled human exposure studies of asthmatic subjects. 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 epidemiologic and experimental data sets form 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 admission.

Although the weight of evidence supporting a causal relationship is somewhat less certain than that associated with respiratory morbidity, NO_2 has also been linked to other health endpoints. These include all-cause (nonaccidental) mortality, hospital admissions or emergency department visits for cardiovascular disease, and decrements in lung function growth associated with chronic exposure.

(c) Health Effects of SO_2

Information on the health effects of SO_2 can be found in the EPA Integrated Science Assessment for Sulfur Oxides.[253] SO_2 has long been known to cause adverse respiratory health effects, particularly among individuals with asthma. Other potentially sensitive groups include 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, the EPA has 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, the EPA has concluded that the overall evidence is suggestive of a causal relationship between short-term exposure to SO_2 and mortality.

(4) Carbon Monoxide

Information on the health effects of CO can be found in the EPA Integrated Science Assessment (ISA) for Carbon Monoxide.[254] The ISA concludes that ambient concentrations of CO are associated with a number of adverse health effects.[255] This section provides a summary of the health effects associated with exposure to ambient concentrations of CO.[256]

[251] National Research Council (NRC), 2008. *Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution.* The National Academies Press: Washington, DC Docket EPA–HQ–OAR–2010–0162

[252] 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. Docket EPA–HQ–OAR–2010–0162 .

[253] 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. Docket EPA–HQ–OAR–2010–0162.

[254] 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.* Docket EPA-HQ-OAR-2010-0162.

[255] 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.

[256] 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.

Human clinical 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 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 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 inconsistent neural and behavioral effects following low-level CO exposures. The 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 epidemiologic and animal toxicological studies cited in the ISA have evaluated associations between CO exposure and 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 associations between perinatal CO exposure and decrements in birth weight, as well as other developmental outcomes. The ISA concludes these studies are suggestive of a causal relationship between long-term exposures to CO and developmental effects and birth outcomes.

Epidemiologic studies provide evidence of effects on respiratory morbidity such as changes in pulmonary function, respiratory symptoms, and hospital admissions associated with ambient CO concentrations. 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 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 ISA concludes that the epidemiologic evidence is suggestive of a causal relationship between short-term exposures to 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 ISA also concludes that there is not likely to be a causal relationship between relevant long-term exposures to CO and mortality.

(5) Air Toxics

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." [257] These compounds include, but are not limited to, benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, diesel particulate matter and exhaust organic gases, polycyclic organic matter, and naphthalene. These compounds were identified as national or regional risk drivers in past National-scale Air Toxics Assessments and have significant inventory contributions from mobile sources.[258]

(a) Diesel Exhaust

Heavy-duty diesel engines emit diesel exhaust, 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 of fine particles (< 2.5 µm), including a subgroup with a large number of 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.[259]

(i) Diesel Exhaust: Potential Cancer Effects

In EPA's 2002 Diesel Health Assessment Document (Diesel HAD),[260] 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. 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) have made similar classifications. However, EPA also concluded in the Diesel HAD that it is not possible currently to calculate a cancer unit risk for diesel exhaust due to a variety of factors that limit the

[257] U.S. EPA. 2002 National-Scale Air Toxics Assessment. *http://www.epa.gov/ttn/atw/nata1 2002/risksum.html.* Docket EPA–HQ–OAR–2010–0162.

[258] U.S. EPA 2009. National-Scale Air Toxics Assessment for 2002. *http://www.epa.gov/ttn/atw/nata2002/.* Docket EPA–HQ–OAR–2010–0162.

[259] 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.* Docket EPA–HQ–OAR–2010–0162.

[260] *See* U.S. EPA (2002) Diesel HAD, Note 259, at pp. 1–1, 1–2.

current studies, such as limited quantitative exposure histories in occupational groups investigated for lung cancer.

For the Diesel HAD, EPA reviewed 22 epidemiologic studies on the subject of the carcinogenicity of workers exposed to diesel exhaust in various occupations, finding increased lung cancer risk, although not always statistically significant, in 8 out of 10 cohort studies and 10 out of 12 case-control studies within several industries. Relative risk for lung cancer associated with exposure ranged from 1.2 to 1.5, although a few studies show relative risks as high as 2.6. Additionally, the Diesel HAD also relied on two independent meta-analyses, which examined 23 and 30 occupational studies respectively, which found statistically significant increases in smoking-adjusted relative lung cancer risk associated with exposure to diesel exhaust of 1.33 to 1.47. These meta-analyses demonstrate the effect of pooling many studies and in this case show the positive relationship between diesel exhaust exposure and lung cancer across a variety of diesel exhaust-exposed occupations.[261] [262]

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 possible risk range by comparing a typical environmental exposure level for highway diesel sources to a selected range of occupational exposure levels. The occupationally observed risks were then proportionally scaled according to the exposure ratios to obtain an estimate of the possible environmental risk. A number of calculations are needed to accomplish this, and these can be seen in the EPA Diesel HAD. The outcome was that environmental risks from diesel exhaust exposure could range from a low of 10^{-4} to 10^{-5} to as high as 10^{-3}, reflecting the range of occupational exposures that could be associated with the relative and absolute risk levels observed in the occupational studies. Because of uncertainties, the analysis acknowledged that the risks could be lower than 10^{-4} or 10^{-5}, and a zero risk from diesel exhaust exposure was not ruled out.

(ii) Diesel Exhaust: Other Health Effects

Noncancer health effects of acute and chronic exposure to diesel exhaust emissions are also of concern to the EPA. EPA derived a diesel exhaust reference concentration (RfC) from consideration of four well-conducted chronic rat inhalation studies showing adverse pulmonary effects.[263] [264] [265] [266] The RfC is 5 μg/m³ for diesel exhaust as measured by diesel particulate matter. This RfC does not consider allergenic effects such as those associated with asthma or immunologic effects. There is growing evidence, discussed in the Diesel HAD, that exposure to diesel exhaust can exacerbate these effects, but the exposure-response data are presently lacking to derive an RfC. The 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." (p. 9–19). The Diesel HAD concludes "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." [267]

(iii) Ambient $PM_{2.5}$ Levels and Exposure to Diesel Exhaust PM

The Diesel HAD also briefly summarizes health effects associated with ambient PM and discusses the EPA's annual $PM_{2.5}$ NAAQS of 15 μg/m³. There is a much more 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 and premature mortality effects of $PM_{2.5}$ as a whole.

(iv) Diesel Exhaust PM Exposures

Exposure of people to diesel exhaust depends on their various activities, the time spent in those activities, the locations where these activities occur, and the levels of diesel exhaust pollutants in those locations. The major difference between ambient levels of diesel particulate and exposure levels for diesel particulate is that exposure accounts for a person moving from location to location, proximity to the emission source, and whether the exposure occurs in an enclosed environment.

Occupational Exposures

Occupational exposures to diesel exhaust from mobile sources can be several orders of magnitude greater than typical exposures in the non-occupationally exposed population.

Over the years, diesel particulate exposures have been measured for a number of occupational groups. A wide range of exposures have been reported, from 2 μg/m³ to 1,280 μg/m³, for a variety of occupations. As discussed in the Diesel HAD, the National Institute of Occupational Safety and Health has estimated a total of 1,400,000 workers are occupationally exposed to diesel exhaust from on-road and nonroad vehicles.

Elevated Concentrations and Ambient Exposures in Mobile Source-Impacted Areas

Regions immediately downwind of highways or truck stops may experience elevated ambient concentrations of directly-emitted $PM_{2.5}$ from diesel engines. Due to the unique nature of highways and truck stops, emissions from a large number of diesel engines are concentrated in a small area. Studies near roadways with high truck traffic indicate higher concentrations of components of diesel PM than other locations.[268] [269] [270] High ambient particle

[261] Bhatia, R., Lopipero, P., Smith, A. (1998). Diesel exposure and lung cancer. *Epidemiology,* 9(1), 84–91. Docket EPA–HQ–OAR–2010–0162.

[262] Lipsett, M. Campleman, S. (1999). Occupational exposure to diesel exhaust and lung cancer: a meta-analysis. *Am J Public Health, 80(7),* 1009–1017. Docket EPA–HQ–OAR–2010–0162.

[263] Ishinishi, N. Kuwabara, N. Takaki, Y., *et al.* (1988). Long-term inhalation experiments on diesel exhaust. In: *Diesel exhaust and health risks.* Results of the HERP studies. Ibaraki, Japan: Research Committee for HERP Studies; pp. 11–84. Docket EPA–HQ–OAR–2010–0162.

[264] Heinrich, U., Fuhst, R., Rittinghausen, S., *et al.* (1995). Chronic inhalation exposure of Wistar rats and two different strains of mice to diesel engine exhaust, carbon black, and titanium dioxide. *Inhal Toxicol,* 7, 553–556. Docket EPA–HQ–OAR–2010–0162.

[265] Mauderly, J.L., Jones, R.K., Griffith, W.C., *et al.* (1987). Diesel exhaust is a pulmonary carcinogen in rats exposed chronically by inhalation. *Fundam. Appl. Toxicol.,* 9, 208–221. Docket EPA–HQ–OAR–2010–0162.

[266] Nikula, K.J., Snipes, M.B., Barr, E.B., *et al.* (1995). Comparative pulmonary toxicities and carcinogenicities of chronically inhaled diesel exhaust and carbon black in F344 rats. *Fundam. Appl. Toxicol,* 25, 80–94. Docket EPA–HQ–OAR–2010–0162.

[267] *See* U.S. EPA (2002), Diesel HAD at Note 259, at p. 9–9.

[268] Zhu, Y.; Hinds, W.C.; Kim, S.; Shen, S.; Sioutas, C. (2002). Study of ultrafine particles near a major highway with heavy-duty diesel traffic. Atmospheric Environment 36: 4323–4335. Docket EPA–HQ–OAR–2010–0162.

[269] Lena, T.S; Ochieng, V.; Holguín-Veras, J.; Kinney, P.L. (2002). Elemental carbon and $PM^{2.5}$ levels in an urban community heavily impacted by truck traffic. Environ Health Perspect 110: 1009–1015. Docket EPA–HQ–OAR–2010–0162.

[270] Soliman, A.S.M.; Jacko, J.B.; Palmer, G.M. (2006). Development of an empirical model to

Continued

concentrations have also been reported near trucking terminals, truck stops, and bus garages.[271] [272] [273] Additional discussion of exposure and health effects associated with traffic is included below in Section VII.B.(5)(j).

(b) Benzene

The 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.[274] [275] [276] 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. 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.[277] [278]

A number of adverse noncancer health effects including blood disorders, such as preleukemia and aplastic anemia, have also been associated with long-term exposure to benzene.[279] [280] The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.[281] [282] In addition, recent work, including studies sponsored by the Health Effects Institute (HEI), provides evidence that biochemical responses are occurring at lower levels of benzene exposure than previously known.[283] [284] [285] [286] EPA's IRIS program has not yet evaluated these new data.

(c) 1,3-Butadiene

EPA has characterized 1,3-butadiene as carcinogenic to humans by inhalation.[287] [288] 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.[289] [290] 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. 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.[291]

(d) Formaldehyde

Since 1987, EPA has classified formaldehyde as a probable human carcinogen based on evidence in humans and in rats, mice, hamsters, and monkeys.[292] EPA is currently reviewing recently published epidemiological data. For instance, research conducted by the National Cancer Institute found an increased risk of nasopharyngeal cancer and lymphohematopoietic malignancies such as leukemia among workers exposed to formaldehyde.[293] [294]

estimate real-world fine particulate matter emission factors: the Traffic Air Quality model. J Air & Waste Manage Assoc 56: 1540–1549. Docket EPA–HQ–OAR–2010–0162.

[271] Davis, M.E.; Smith, T.J.; Laden, F.; Hart, J.E.; Ryan, L.M.; Garshick, E. (2006). Modeling particle exposure in U.S. trucking terminals. Environ Sci Techol 40: 4226–4232. Docket EPA–HQ–OAR–2010–0162.

[272] Miller, T.L.; Fu, J.S.; Hromis, B.; Storey, J.M. (2007). Diesel truck idling emissions—measurements at a PM2.5 hot spot. Proceedings of the Annual Conference of the Transportation Research Board, paper no. 07–2609. Docket EPA–HQ–OAR–2010–0162.

[273] Ramachandran, G.; Paulsen, D.; Watts, W.; Kittelson, D. (2005). Mass, surface area, and number metrics in diesel occupational exposure assessment. J Environ Monit 7: 728–735. Docket EPA–HQ–OAR–2010–0162.

[274] U.S. EPA. 2000. Integrated Risk Information System File for Benzene. This material is available electronically at *http://www.epagov/iris/subst/0276.htm.* Docket EPA–HQ–OAR–2010–0162.

[275] International Agency for Research on Cancer. 1982. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29. Some industrial chemicals and dyestuffs, World Health Organization, Lyon, France, p. 345–389. Docket EPA–HQ–OAR–2010–0162.

[276] 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. Docket EPA–HQ–OAR–2010–0162.

[277] *See* IARC, Note 275, above.

[278] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at: *http://ntp.niehs.nih.gov/go/16183.* Docket EPA–HQ–OAR–2010–0162.

[279] Aksoy, M. (1989). Hematotoxicity and carcinogenicity of benzene. Environ. Health Perspect. 82: 193–197. Docket EPA–HQ–OAR–2010–0162.

[280] Goldstein, B.D. (1988). Benzene toxicity. Occupational medicine. State of the Art Reviews. 3: 541–554. Docket EPA–HQ–OAR–2010–0162.

[281] 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. Docket EPA–HQ–OAR–2010–0162.

[282] U.S. EPA (2002). Toxicological Review of Benzene (Noncancer Effects). 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/ubst/0276.htm.* Docket EPA–HQ–OAR–2010–0162.

[283] 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. Docket EPA–HQ–OAR–2010–0162.

[284] 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. Docket EPA–HQ–OAR–2010–0162.

[285] Lan, Qing, Zhang, L., Li, G., Vermeulen, R., *et al.* (2004). Hematotoxically in Workers Exposed to Low Levels of Benzene. Science 306: 1774–1776. Docket EPA–HQ–OAR–2010–0162.

[286] 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. Docket EPA–HQ–OAR–2010–0162.

[287] 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.* Docket EPA–HQ–OAR–2010–0162.

[288] 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.* Docket EPA–HQ–OAR–2010–0162.

[289] International Agency for Research on Cancer (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. Docket EPA–HQ–OAR–2010–0162.

[290] U.S. Department of Health and Human Services (2005). National Toxicology Program 11th Report on Carcinogens available at: *ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932.* Docket EPA–HQ–OAR–2010–0162.

[291] 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. Docket EPA–HQ–OAR–2010–0162.

[292] U.S. EPA (1987). Assessment of Health Risks to Garment Workers and Certain Home Residents from Exposure to Formaldehyde, Office of Pesticides and Toxic Substances, April 1987. Docket EPA–HQ–OAR–2010–0162.

[293] 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. Docket EPA–HQ–OAR–2010–0162.

[294] 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. Docket EPA–HQ–OAR–2010–0162.

In an analysis of the lymphohematopoietic cancer mortality from an extended follow-up of these workers, the National Cancer Institute confirmed an association between lymphohematopoietic cancer risk and peak exposures.[295] A recent National Institute of Occupational Safety and Health study of garment workers also found increased risk of death due to leukemia among workers exposed to formaldehyde.[296] Extended follow-up of a cohort of British chemical workers did not find evidence of an increase in nasopharyngeal or lymphohematopoietic cancers, but a continuing statistically significant excess in lung cancers was reported.[297] Recently, the IARC re-classified formaldehyde as a human carcinogen (Group 1).[298]

Formaldehyde exposure also causes a range of noncancer health effects, including irritation of the eyes (burning and watering of the eyes), nose and throat. Effects from repeated exposure in humans include respiratory tract irritation, chronic bronchitis and nasal epithelial lesions such as metaplasia and loss of cilia. Animal studies suggest that formaldehyde may also cause airway inflammation—including eosinophil infiltration into the airways. There are several studies that suggest that formaldehyde may increase the risk of asthma—particularly in the young.[299] [300]

(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.[301] Acetaldehyde is reasonably anticipated to be a human carcinogen by the U.S. DHHS in the 11th Report on Carcinogens and is classified as possibly carcinogenic to humans (Group 2B) by the IARC.[302] [303] 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.[304] In short-term (4 week) rat studies, degeneration of olfactory epithelium was observed at various concentration levels of acetaldehyde exposure.[305] [306] Data from these studies were used by EPA to develop an inhalation reference concentration. Some asthmatics have been shown to be a sensitive subpopulation to decrements in functional expiratory volume (FEV1 test) and bronchoconstriction upon acetaldehyde inhalation.[307] The agency is currently conducting a reassessment of the health hazards from inhalation exposure to acetaldehyde.

(f) Acrolein

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.[308] 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.[309] Evidence available from 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.[310] Lesions to the lungs and upper respiratory tract of rats, rabbits, and hamsters have been observed after subchronic exposure to acrolein.[311] Acute exposure effects in animal studies report bronchial hyper-responsiveness.[312] In a recent study, the acute respiratory irritant effects of exposure to 1.1 ppm acrolein were more pronounced in mice with allergic airway disease by comparison to non-diseased mice which also showed decreases in respiratory rate.[313] Based on these animal data 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 determined in 2003 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

[295] Beane Freeman, L.E.; Blair, A.; Lubin, J.H.; Stewart, P.A.; Hayes, R.B.; Hoover, R.N.; Hauptmann, M. 2009. Mortality from lymphohematopoietic malignancies among workers in formaldehyde industries: The National Cancer Institute cohort. J. National Cancer Inst. 101: 751–761. Docket EPA–HQ–OAR–2010–0162.

[296] Pinkerton, L.E. 2004. Mortality among a cohort of garment workers exposed to formaldehyde: an update. Occup. Environ. Med. 61: 193–200. Docket EPA–HQ–OAR–2010–0162.

[297] Coggon, D, EC Harris, J Poole, KT Palmer. 2003. Extended follow-up of a cohort of British chemical workers exposed to formaldehyde. J National Cancer Inst. 95:1608–1615. Docket EPA–HQ–OAR–2010–0162.

[298] International Agency for Research on Cancer. 2006. Formaldehyde, 2-Butoxyethanol and 1-tert-Butoxypropan-2-ol. Volume 88. (in preparation), World Health Organization, Lyon, France. Docket EPA–HQ–OAR–2010–0162.

[299] Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for Formaldehyde. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. *http://ww.atsdr.cdc.gov/toxprofiles/tp111.html.* Docket EPA–HQ–OAR–2010–0162.

[300] WHO (2002). Concise International Chemical Assessment Document 40: Formaldehyde. Published under the joint sponsorship of the United Nations Environment Programme, the International Labour Organization, and the World Health Organization, and produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals. Geneva. Docket EPA–HQ–OAR–2010–0162.

[301] U.S. EPA. 1991. Integrated Risk Information System File of Acetaldehyde. Research and Development, National Center for Environmental Assessment, Washington, DC. Available at *http://www.epa.gov/iris/subst/0290.htm.* Docket EPA–HQ–OAR–2010–0162.

[302] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at: *ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932.* Docket EPA–HQ–OAR–2010–0162.

[303] International Agency for Research on Cancer. 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. Docket EPA–HQ–OAR–2010–0162.

[304] *See* Integrated Risk Information System File of Acetaldehyde, Note 301, above.

[305] Appleman, L.M., R.A. Woutersen, V.J. Feron, R.N. Hooftman, and W.R.F. Notten. 1986. Effects of the variable versus fixed exposure levels on the toxicity of acetaldehyde in rats. *J. Appl. Toxicol.* 6: 331–336. Docket EPA–HQ–OAR–2010–0162

[306] 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. Docket EPA–HQ–OAR–2010–0162.

[307] 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): 940–3. Docket EPA–HQ–OAR–2010–0162.

[308] U.S. EPA (U.S. Environmental Protection Agency). (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/ris/toxreviews/0364tr.pdf.* Docket EPA–HQ–OAR–2010–0162.

[309] *See* U.S. EPA 2003 Toxicological review of acrolein, Note 308, above.

[310] *See* U.S. EPA 2003 Toxicological review of acrolein, Note 308, at p. 11.

[311] 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.* Docket EPA–HQ–OAR–2010–0162.

[312] *See* U.S. 2003 Toxicological review of acrolein, Note 308, at p. 15.

[313] 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. Docket EPA–HQ–OAR–2010–0162.

acrolein in humans and the animal data provided inadequate evidence of carcinogenicity.[314] The IARC determined in 1995 that acrolein was not classifiable as to its carcinogenicity in humans.[315]

(g) Polycyclic Organic Matter

Polycyclic organic matter is generally defined as a large class of organic compounds which have multiple benzene rings and a boiling point greater than 100° Celsius. Many of the compounds included in the class of compounds known as polycyclic organic matter are classified by EPA as probable human carcinogens based on animal data. One of these compounds, naphthalene, is discussed separately below. Polycyclic aromatic hydrocarbons are a subset of polycyclic organic matter that contains only hydrogen and carbon atoms. A number of polycyclic aromatic hydrocarbons are known or suspected carcinogens. Recent studies have found that maternal exposures to polycyclic aromatic hydrocarbons (a subclass of polycyclic organic matter) 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 at age three.[316] [317] EPA has not yet evaluated these recent studies.

(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. EPA released an external review draft of a reassessment of the inhalation carcinogenicity of naphthalene based on a number of recent animal carcinogenicity studies.[318] The draft reassessment completed external peer review.[319] Based on external peer review comments received, additional analyses are being undertaken. This 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.[320] 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.[321] Naphthalene also causes a number of chronic non-cancer effects in animals, including abnormal cell changes and growth in respiratory and nasal tissues.[322]

(i) Other Air Toxics

In addition to the compounds described above, other compounds in gaseous hydrocarbon and PM emissions from heavy-duty vehicles will be affected by this proposal. Mobile source air toxic compounds that would 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.[323]

(j) Exposure and Health Effects Associated With Traffic

Populations who live, work, or attend school near major roads experience elevated exposure concentrations to a wide range of air pollutants, as well as higher risks for a number of adverse health effects. While the previous sections of this preamble have focused on the health effects associated with individual criteria pollutants or air toxics, this section discusses the mixture of different exposures near major roadways, rather than the effects of any single pollutant. As such, this section emphasizes traffic-related air pollution, in general, as the relevant indicator of exposure rather than any particular pollutant.

Concentrations of many traffic-generated air pollutants are elevated for up to 300–500 meters downwind of roads with high traffic volumes.[324] Numerous sources on roads contribute to elevated roadside concentrations, including exhaust and evaporative emissions, and resuspension of road dust and tire and brake wear. Concentrations of several criteria and hazardous air pollutants are elevated near major roads. Furthermore, different semi-volatile organic compounds and chemical components of particulate matter, including elemental carbon, organic material, and trace metals, have been reported at higher concentrations near major roads.

Populations near major roads experience greater risk of certain adverse health effects. The Health Effects Institute published a report on the health effects of traffic-related air pollution.[325] It concluded that evidence is "sufficient to infer the presence of a causal association" between traffic exposure and exacerbation of childhood asthma symptoms. The HEI report also concludes that the evidence is either "sufficient" or "suggestive but not sufficient" for a causal association between traffic exposure and new childhood asthma cases. A review of asthma studies by Salam *et al.* (2008)

[314] 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* Docket EPA–HQ–OAR–2010–0162.

[315] International Agency for Research on Cancer. 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. Docket EPA–HQ–OAR–2010–0162.

[316] 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. Docket EPA–HQ–OAR–2010–0162.

[317] 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. Docket EPA–HQ–OAR–2010–0162.

[318] U. S. EPA. 2004. 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/436.htm.* Docket EPA–HQ–OAR–2010–0162.

[319] 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.* Docket EPA–HQ–OAR–2010–0162.

[320] National Toxicology Program (NTP). (2004). 11th Report on Carcinogens. Public Health Service, U.S. Department of Health and Human Services, Research Triangle Park, NC. Available from: *http://ntp-server.niehs.nih.gov.* Docket EPA–HQ–OAR–2010–0162.

[321] International Agency for Research on Cancer. (2002). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans. Vol. 82. Lyon, France. Docket EPA–HQ–OAR–2010–0162.

[322] 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.* Docket EPA–HQ–OAR–2010–0162.

[323] U.S. EPA Integrated Risk Information System (IRIS) database is available at: *http://www.epa.gov/iris.*

[324] Zhou, Y.; Levy, J.I. (2007). Factors influencing the spatial extent of mobile source air pollution impacts: A meta-analysis. BMC Public Health 7: 89. doi:10.1186/1471–2458–7–89 Docket EPA–HQ–OAR–2010–0162.

[325] HEI Panel on the Health Effects of Air Pollution. (2010). Traffic-related air pollution: A critical review of the literature on emissions, exposure, and health effects. [Online at *http://www.healtheffects.org.*] Docket EPA–HQ–OAR–2010–0162.

reaches similar conclusions.[326] The HEI report also concludes that there is "suggestive" evidence for pulmonary function deficits associated with traffic exposure, but concluded that there is "inadequate and insufficient" evidence for causal associations with respiratory health care utilization, adult-onset asthma, chronic obstructive pulmonary disease symptoms, and allergy. A review by Holguin (2008) notes that the effects of traffic on asthma may be modified by nutrition status, medication use, and genetic factors.[327]

The HEI report also concludes that evidence is "suggestive" of a causal association between traffic exposure and all-cause and cardiovascular mortality. There is also evidence of an association between traffic-related air pollutants and cardiovascular effects such as changes in heart rhythm, heart attack, and cardiovascular disease. The HEI report characterizes this evidence as "suggestive" of a causal association, and an independent epidemiological literature review by Adar and Kaufman (2007) concludes that there is "consistent evidence" linking traffic-related pollution and adverse cardiovascular health outcomes.[328]

Some studies have reported associations between traffic exposure and other health effects, such as birth outcomes (*e.g.,* low birth weight) and childhood cancer. The HEI report concludes that there is currently "inadequate and insufficient" evidence for a causal association between these effects and traffic exposure. A review by Raaschou-Nielsen and Reynolds (2006) concluded that evidence of an association between childhood cancer and traffic-related air pollutants is weak, but noted the inability to draw firm conclusions based on limited evidence.[329]

There is a large population in the United States living in close proximity of major roads. According to the Census Bureau's American Housing Survey for 2007, approximately 20 million residences in the United States, 15.6% of all homes, are located within 300 feet (91 m) of a highway with 4+ lanes, a railroad, or an airport.[330] Therefore, at current population of approximately 309 million, assuming that population and housing are similarly distributed, there are over 48 million people in the United States living near such sources. The HEI report also notes that in two North American cities, Los Angeles and Toronto, over 40% of each city's population live within 500 meters of a highway or 100 meters of a major road. It also notes that about 33% of each city's population resides within 50 meters of major roads. Together, the evidence suggests that a large U.S. population lives in areas with elevated traffic-related air pollution.

People living near roads are often socioeconomically disadvantaged. According to the 2007 American Housing Survey, a renter-occupied property is over twice as likely as an owner-occupied property to be located near a highway with 4+ lanes, railroad or airport. In the same survey, the median household income of rental housing occupants was less than half that of owner-occupants ($28,921/ $59,886). Numerous studies in individual urban areas report higher levels of traffic-related air pollutants in areas with high minority or poor populations.[331 332 333]

Students may also be exposed in situations where schools are located near major roads. In a study of nine metropolitan areas across the United States, Appatova et al. (2008) found that on average greater than 33% of schools were located within 400 m of an Interstate, U.S., or State highway, while 12% were located within 100 m.[334] The study also found that among the metropolitan areas studied, schools in the Eastern United States were more often sited near major roadways than schools in the Western United States.

Demographic studies of students in schools near major roadways suggest that this population is more likely than the general student population to be of non-white race or Hispanic ethnicity, and more often live in low socioeconomic status locations.[335 336 337] There is some inconsistency in the evidence, which may be due to different local development patterns and measures of traffic and geographic scale used in the studies.[334]

C. Environmental Effects of Non-GHG Pollutants

In this section we discuss some of the environmental effects of PM and its precursors such as visibility impairment, atmospheric deposition, and materials damage and soiling, as well as environmental effects associated with the presence of ozone in the ambient air, such as impacts on plants, including trees, agronomic crops and urban ornamentals, and environmental effects associated with air toxics.

(1) Visibility

Visibility can be defined as the degree to which the atmosphere is transparent to visible light.[338] 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

[326] Salam, M.T.; Islam, T.; Gilliland, F.D. (2008). Recent evidence for adverse effects of residential proximity to traffic sources on asthma. Current Opin Pulm Med 14: 3–8. Docket EPA–HQ–OAR–2010–0162.

[327] Holguin, F. (2008). Traffic, outdoor air pollution, and asthma. Immunol Allergy Clinics North Am 28: 577–588. Docket EPA–HQ–OAR–2010–0162.

[328] Adar, S.D.; Kaufman, J.D. (2007). Cardiovascular disease and air pollutants: Evaluating and improving epidemiological data implicating traffic exposure. Inhal Toxicol 19: 135–149. Docket EPA–HQ–OAR–2010–0162.

[329] Raaschou-Nielsen, O.; Reynolds, P. (2006). Air pollution and childhood cancer: A review of the epidemiological literature. Int J Cancer 118: 2920–2929. Docket EPA–HQ–OAR–2010–0162.

[330] U.S. Census Bureau (2008). American Housing Survey for the United States in 2007. Series H–150 (National Data), Table 1A–7. [Accessed at *http://www.census.gov/hhes/www/housing/ahs/ahs07/ahs07.html* on January 22, 2009] Docket EPA–HQ–OAR–2010–0162.

[331] Lena, T.S.; Ochieng, V.; Carter, M.; Holguín-Veras, J.; Kinney, P.L. (2002). Elemental carbon and PM2.5 levels in an urban community heavily impacted by truck traffic. Environ Health Perspect 110: 1009–1015. Docket EPA–HQ–OAR–2010–0162.

[332] Wier, M.; Sciammas, C.; Seto, E.; Bhatia, R.; Rivard, T. (2009). Health, traffic, and environmental justice: collaborative research and community action in San Francisco, California. Am J Public Health 99: S499–S504. Docket EPA–HQ–OAR–2010–0162.

[333] Forkenbrock, D.J. and L.A. Schweitzer, *Environmental Justice and Transportation Investment Policy.* Iowa City: University of Iowa, 1997. Docket EPA–HQ–OAR–2010–0162.

[334] Appatova, A.S.; Ryan, P.H.; LeMasters, G.K.; Grinshpun, S.A. (2008). Proximal exposure of public schools and students to major roadways: A nationwide U.S. survey. J Environ Plan Mgmt Docket EPA–HQ–OAR–2010–0162.

[335] Green, R.S.; Smorodinsky, S.; Kim, J.J.; McLaughlin, R.; Ostro, B. (2004). Proximity of California public schools to busy roads. Environ Health Perspect 112: 61–66. Docket EPA–HQ–OAR–2010–0162.

[336] Houston, D.; Ong, P.; Wu, J.; Winer, A. (2006). Proximity of licensed child care facilities to near-roadway vehicle pollution. Am J Public Health 96: 1611–1617. Docket EPA–HQ–OAR–2010–0162.

[337] Wu, Y.; Batterman, S. (2006). Proximity of schools in Detroit, Michigan to automobile and truck traffic. J Exposure Sci Environ Epidemiol 16: 457–470. Docket EPA–HQ–OAR–2010–0162.

[338] 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. Docket EPA–HQ–OAR–2010–0162. This book can be viewed on the National Academy Press Web site at *http://www.nap.edu/books/0309048443/html/.*

areas. For more information on visibility see the final 2009 PM ISA.[339]

EPA is pursuing a two-part strategy to address visibility. First, EPA has concluded that PM2.5 causes adverse effects on visibility in various locations, depending on PM concentrations and factors such as chemical composition and average relative humidity, and has set secondary $PM_{2.5}$ standards.[340] The secondary PM2.5 standards act in conjunction with the regional haze program. EPA's regional haze rule (64 FR 35714) was put in place in July 1999 to protect the visibility in Mandatory Class I Federal areas. There are 156 national parks, forests and wilderness areas categorized as Mandatory Class I Federal areas (62 FR 38680–38681, July 18, 1997).[341] Visibility can be said to be impaired in both PM2.5 nonattainment areas and Mandatory Class I Federal areas.

(2) Plant and Ecosystem Effects of Ozone

Elevated ozone levels contribute to environmental effects, with impacts to plants and ecosystems being of most concern. Ozone can produce both acute and chronic injury in sensitive species depending on the concentration level and the duration of the exposure. Ozone effects also tend to accumulate over the growing season of the plant, so that even low concentrations experienced for a longer duration have the potential to create chronic stress on vegetation. Ozone damage to plants includes visible injury to leaves and impaired photosynthesis, both of which can lead to reduced plant growth and reproduction, resulting in reduced crop yields, forestry production, and use of sensitive ornamentals in landscaping. In addition, the impairment of photosynthesis, the process by which the plant makes carbohydrates (its source of energy and food), can lead to a subsequent reduction in root growth and carbohydrate storage below ground, resulting in other, more subtle plant and ecosystems impacts.

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 forest and other natural vegetation can potentially lead to species shifts and loss from the affected ecosystems, resulting in a loss or reduction in associated ecosystem goods and services. Lastly, 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. The final 2006 Ozone Air Quality Criteria Document presents more detailed information on ozone effects on vegetation and ecosystems.

(3) Atmospheric Deposition

Wet and dry deposition of ambient particulate matter delivers a complex mixture of metals (*e.g.,* mercury, zinc, lead, nickel, aluminum, cadmium), organic compounds (*e.g.,* polycyclic organic matter, dioxins, 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. 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.[342]

Adverse impacts on water quality can occur when atmospheric contaminants deposit to the water surface or when material deposited on the land enters a waterbody through runoff. Potential impacts of atmospheric deposition to waterbodies include those related to both nutrient and toxic inputs. Adverse effects to human health and welfare can occur from the addition of excess nitrogen via atmospheric deposition. The nitrogen-nutrient enrichment contributes to toxic algae blooms and zones of depleted oxygen, which can lead to fish kills, frequently in coastal waters. Deposition of heavy metals or other toxics may lead to the human ingestion of contaminated fish, impairment of drinking water, damage to the marine ecology, and limits to recreational uses. Several studies have been conducted in U.S. coastal waters and in the Great Lakes Region in which the role of ambient PM deposition and runoff is investigated.[343 344 345 346 347]

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 nutritional value of preferred prey species, threatening biodiversity 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 include a decline in sensitive forest tree species, such as red spruce (*Picea rubens*) and sugar maple (*Acer saccharum*), and a loss of biodiversity of fishes, zooplankton, and macro invertebrates.

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 Section 7.1.2 of the draft RIA.

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[339] *See* U.S. EPA 2009. Final PM ISA, Note 243.

[340] The existing annual primary and secondary $PM_{2.5}$ standards have been remanded and are being addressed in the currently ongoing PM NAAQS review.

[341] 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.

[342] 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. Docket EPA–HQ–OAR–2010–0162.

[343] U.S. EPA (2004). National Coastal Condition Report II. Office of Research and Development/ Office of Water. EPA–620/R–03/002. Docket EPA–HQ–OAR–2010–0162.

[344] Gao, Y., E.D. Nelson, M.P. Field, *et al.* 2002. Characterization of atmospheric trace elements on PM2.5 particulate matter over the New York-New Jersey harbor estuary. *Atmos. Environ.* 36: 1077–1086. Docket EPA–HQ–OAR–2010–0162.

[345] Kim, G., N. Hussain, J.R. Scudlark, and T.M. Church. 2000. Factors influencing the atmospheric depositional fluxes of stable Pb, 210Pb, and 7Be into Chesapeake Bay. *J. Atmos. Chem.* 36: 65–79. Docket EPA–HQ–OAR–2010–0162.

[346] Lu, R., R.P. Turco, K. Stolzenbach, *et al.* 2003. Dry deposition of airborne trace metals on the Los Angeles Basin and adjacent coastal waters. *J. Geophys. Res.* 108(D2, 4074): AAC 11–1 to 11–24. Docket EPA–HQ–OAR–2010–0162.

[347] Marvin, C.H., M.N. Charlton, E.J. Reiner, *et al.* 2002. Surficial sediment contamination in Lakes Erie and Ontario: A comparative analysis. *J. Great Lakes Res.* 28(3): 437–450. Docket EPA–HQ–OAR–2010–0162.

Adverse impacts on soil chemistry and plant life have been observed for areas heavily influenced by atmospheric deposition of nutrients, metals and acid species, resulting in species shifts, loss of biodiversity, forest decline and damage to forest productivity. Potential impacts also include adverse effects to human health through ingestion of contaminated vegetation or livestock (as in the case for dioxin deposition), reduction in crop yield, and limited use of land due to contamination.

Atmospheric deposition of pollutants can reduce the aesthetic appeal of buildings and culturally important articles through soiling, and can contribute directly (or in conjunction with other pollutants) to structural damage by means of corrosion or erosion. Atmospheric deposition may affect materials principally by promoting and accelerating the corrosion of metals, by degrading paints, and by deteriorating building materials such as concrete and limestone. Particles contribute to these effects because of their electrolytic, hygroscopic, and acidic properties, and their ability to adsorb corrosive gases (principally sulfur dioxide).

(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.[348] In laboratory experiments, a wide range of tolerance to VOCs has been observed.[349] 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.[350]

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.[351] [352] [353] The impacts of VOCs on plant reproduction may have long-term implications for biodiversity and survival of native species near major roadways. Most of the studies of the impacts of VOCs on vegetation have focused on short-term exposure and few studies have focused on long-term effects of VOCs on vegetation and the potential for metabolites of these compounds to affect herbivores or insects.

D. Air Quality Impacts of Non-GHG Pollutants

(1) Current Levels of Non-GHG Pollutants

This proposal may have impacts on ambient concentrations of criteria and air toxic pollutants. Nationally, levels of $PM_{2.5}$, ozone, NO_X, SO_X, CO and air toxics are declining.[354] However, approximately 127 million people lived in counties that exceeded any NAAQS in 2008.[355] These numbers do not include the people living in areas where there is a future risk of failing to maintain or attain the NAAQS. It is important to note that these numbers do not account for potential SO_2, NO_2 or Pb nonattainment areas which have not yet been designated. Also, EPA is currently reviewing the standards for PM and CO, and those standards could be made more protective, which would increase the number of people living in nonattainment areas.

Further, 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.[356] [357] The levels of air toxics to which people are exposed vary depending on where people live and work and the kinds of activities in which they engage, as discussed in detail in U.S. EPA's recent mobile source air toxics rule.[358]

(2) Impacts of Proposed Standards on Future Ambient Concentrations of $PM_{2.5}$, Ozone and Air Toxics

Full-scale photochemical air quality modeling is necessary to accurately project levels of criteria pollutants and air toxics. For the final rulemaking, a national-scale air quality modeling analysis will be performed to analyze the impacts of the standards on $PM_{2.5}$, ozone, and selected air toxics (*i.e.,* benzene, formaldehyde, acetaldehyde, 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.

Sections VII.A and VII.B of the preamble present 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 6 of the draft RIA. 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, EPA expects that there will be a relatively small change in ambient air quality, pending a more comprehensive analysis for the final rulemaking.

For the final rulemaking, EPA intends to use a 2005-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).[359] [360] [361] [362]

[348] U.S. EPA. 1991. Effects of organic chemicals in the atmosphere on terrestrial plants. EPA/600/3–91/001. Docket EPA–HQ–OAR–2010–0162.

[349] 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. Docket EPA–HQ–OAR–2010–0162.

[350] 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. Docket EPA–HQ–OAR–2010–0162.

[351] Viskari E–L. 2000. Epicuticular wax of Norway spruce needles as indicator of traffic pollutant deposition. Water, Air, and Soil Pollut. 121:327–337. Docket EPA–HQ–OAR–2010–0162.

[352] Ugrekhelidze D, F Korte, G Kvesitadze. 1997. Uptake and transformation of benzene and toluene by plant leaves. Ecotox. Environ. Safety 37:24–29. Docket EPA–HQ–OAR–2010–0162.

[353] Kammerbauer H, H Selinger, R Rommelt, A Ziegler-Jons, D Knoppik, B Hock. 1987. Toxic components of motor vehicle emissions for the spruce Picea abies. Environ. Pollut. 48:235–243. Docket EPA–HQ–OAR–2010–0162.

[354] U.S. EPA (2010). Our Nation's Air: Status and Trends through 2008. Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA 454/R–09–002. *http://www.epa.gov/airtrends/2010/.* Docket EPA–HQ–OAR–2010–0162.

[355] *See* U.S. EPA Trends, Note 354.

[356] U.S. Environmental Protection Agency (2007). Control of Hazardous Air Pollutants from Mobile Sources; Final Rule. 72 FR 8434, February 26, 2007.

[357] *See* U.S. EPA 2010, Light-Duty 2012–2016 MY Vehicle Rule, Note 6.

[358] *See* U.S. EPA 2007, Note 356.

[359] U.S. Environmental Protection Agency, Byun, D.W., and Ching, J.K.S., Eds, 1999. Science algorithms of EPA Models-3 Community Multiscale

Continued

The CMAQ model is a well-known and well-established tool and is commonly used by EPA for regulatory analyses, for instance the recent ozone NAAQS proposal, and by States in developing attainment demonstrations for their State Implementation Plans.[363] The CMAQ model version 4.7 was most recently peer-reviewed in February of 2009 for the U.S. EPA.[364]

CMAQ includes many science modules that simulate the emission, production, decay, deposition and transport of organic and inorganic gas-phase and particle-phase pollutants in the atmosphere. EPA intends to use the most recent version of CMAQ which reflects updates to version 4.7 to improve the underlying science. These include aqueous chemistry mass conservation improvements, improved vertical convective mixing and lowered CB05 mechanism unit yields for acrolein from 1,3-butadiene tracer reactions which were updated to be consistent with laboratory measurements.

VIII. What are the agencies' estimated cost, economic, and other impacts of the proposed program?

In this section, we present the costs and impacts of the proposed HD National Program. 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 economy increases and GHG emission reductions. The two agencies' proposed standards would comprise the HD National Program.

The net benefits of the proposed HD National Program consist of the effects of the program on:

- The vehicle program costs (costs of complying with the vehicle CO_2 standards)
- Fuel savings associated with reduced fuel usage resulting from the program
- The economic value of reductions in greenhouse gas emissions,
- The reductions in other (non-GHG) pollutants,
- Costs associated with increases in noise, congestion, and accidents resulting from increased vehicle use,
- The economic value of improvements in U.S. energy security impacts,
- Benefits associated with increased vehicle use due to the "rebound" effect.

We also present the cost-effectiveness of the standards, or the cost per ton of emissions reduced. A few effects of the program, such as the effects on other pollutants, are not included here. We plan to add the effects of other pollutants to the analysis for the final rules.

The program may have other 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 Section III 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. In addition, the analysis assumes that the full technology costs are passed along to vehicle buyers. With these assumptions, because welfare losses are monetary estimates of how much buyers would have to be compensated to be made as well off as in the absence of the change,[365] the price increase measures the loss to the buyer.[366] Assuming that the full technology cost gets passed along to the buyer as an increase in price, the technology cost thus measures the welfare loss to the buyer. Increasing fuel economy would have to lead to other changes in the vehicles that buyers find undesirable for there to be additional losses not included in the technology costs.

The costs estimates include the costs of holding other vehicle attributes, such as performance, constant. The 2010 light-duty GHG/CAFE rule, discussed that if other vehicle attributes are not held constant, then the cost estimates do not capture the impacts of these changes.[367] The light duty rule also discussed other potential issues that could affect the calculation of the welfare impacts of these types of changes, such as behavioral issues affecting the demand for technology investments, investment horizon uncertainty, 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, if possible, of any additional impacts of the proposed standards on vehicle attributes and performance, and other potential aspects that could positively or negatively affect the welfare implications of this proposed rulemaking, not addressed in this analysis.

The total monetized benefits (excluding fuel savings) under the program are projected to be $1.5 to $7.9 billion in 2030, depending on the value used for the social cost of carbon. These benefits are summarized below in Table VIII–25. The costs of the program in 2030 are estimated to be approximately $1.9 billion for new engine and truck technology less $19 billion in savings realized by trucking operations through fewer fuel expenditures (calculated using pre-tax fuel prices). These costs are summarized below in Table VIII–24. The present value of the total monetized benefits (excluding fuel savings) under the program are expected to range from $23 billion to $150 billion with a 3% discount rate; with a 7% discount rate, the total monetized benefits are expected to range from $15 billion to

Air Quality (CMAQ modeling system, EPA/600/R–99/030, Office of Research and Development). Docket EPA–HQ–OAR–2010–0162.

[360] Byun, D.W., and Schere, K.L., 2006. Review of the Governing Equations, Computational Algorithms, and Other Components of the Models-3 Community Multiscale Air Quality (CMAQ) Modeling System, J. Applied Mechanics Reviews, 59 (2), 51–77. Docket EPA–HQ–OAR–2010–0162.

[361] 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.

[362] 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.

[363] 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

[364] Allen, D. *et al.* (2009). Report on the Peer Review of the Atmospheric Modeling and Analysis Division, National Exposure Research Laboratory, Office of Research and Development, U.S. EPA. *http://www.epa.gov/asmdnerl/peer/reviewdocs.html.* Docket EPA–HQ–OAR–2010–0162.

[365] 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.

[366] Indeed, it is likely to be an overestimate of the loss to the consumer, because the consumer 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 consumer 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 consumer faces would be the upper bound of loss of consumer welfare, unless there are other changes to the vehicle due to the fuel economy improvements that make the vehicle less desirable to consumers.

[367] Environmental Protection Agency and Department of Transportation, "Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards; Final Rule," **Federal Register** 75(88) (May 7, 2010). *See* especially sections III.H.1 (pp. 25510–25513) and IV.G.6 (pp. 25651–25657).

$140 billion. These values, summarized in Table VIII–25, depend on the value used for the social cost of carbon. The present value of costs of the program for new engine and truck technology, in Table VIII–24, are expected to be $42 billion using a 3% discount rate, and $23 billion with a 7% discount rate, less fuel savings (calculated using pre-tax fuel prices) of $350 billion with a 3% discount rate, and $150 billion with a 7% discount rate. Total present net benefits (in Table VIII–26) are thus expected to range from $330 billion to $460 billion with a 3% discount rate, and $150 billion to $270 billion with a 7% discount rate.

The estimates developed here are measured against a baseline fuel economy associated with MY 2010 vehicles. The extent to which fuel economy improvements may have occurred in the absence of the rules affect the net benefits associated with the rule. If trucks would have ended up installing technologies to achieve the fuel savings and reduced GHG emissions in the absence of this proposal, then both the costs and benefits of these fuel savings could be attributed to market forces, not the rules. At this time, the agencies do not have estimates of the extent of fuel-saving technologies that might have been adopted in the absence of this proposal. We seek comment on whether the agencies should use an alternative baseline based on data provided by commenters to estimate the degree to which the technologies discussed in this proposal would have been adopted in the absence of this proposal.

EPA has undertaken an analysis of the economy-wide impacts of the proposed heavy-duty truck fuel efficiency and GHG standards as an exploratory exercise that EPA believes could provide additional insights into the potential impacts of the program.[368] These results were not a factor regarding the appropriateness of the proposed standards. It is important to note that the results of this modeling exercise are dependent on the assumptions associated with how manufacturers would make fuel efficiency improvements and how trucking operations would respond to increases in higher vehicle costs and improved vehicle fuel efficiency as a result of the proposed program.

Further information on these and other aspects of the economic impacts of our rules are summarized in the following sections and are presented in more detail in the draft RIA for this proposed rulemaking.

A. Conceptual Framework for Evaluating Impacts

This regulation is motivated primarily by the goals of reducing emissions of greenhouse gases and promoting U.S. energy security by reducing consumption and imports of petroleum-based fuels. These motivations involve classic externalities, meaning that private decisions do not incorporate all of the costs associated with these problems; these costs are not borne completely by the households or businesses whose actions are responsible for them. In the absence of some mechanism to "internalize" these costs—that is, to transfer their burden to individuals or firms whose decisions impose them—individuals and firms will consume more petroleum-based fuels than is socially optimal. Externalities are a classic motivation for government intervention in markets. These externalities, as well as effects due to changes in emissions of other pollutants and other impacts, are discussed in Sections VIII.H–VIII.J.

In some cases, these classic externalities are by themselves enough to justify the costs of imposing fuel efficiency standards. For some discount rates and some projected social costs of carbon, however, the reductions in these external costs are less than the costs of new fuel saving technologies needed to meet the standards. (*See* Tables 9–18 and 9–19 in the draft RIA.) Nevertheless, this regulation reduces trucking companies' fuel costs; according to our estimates, these savings in fuel costs are *by themselves* sufficient to pay for the technologies over periods of time considerably shorter than vehicles' expected lifetimes under the assumptions used for this analysis (*e.g.*, AEO 2010 projected fuel prices). If these estimates are correct, then the *entire* value of the reductions in external costs represents additional net benefits of the rule, beyond those resulting from the fact that the value of fuel savings exceeds the costs of technologies necessary to achieve them.

It is often asserted that there are cost-effective fuel-saving technologies that truck companies are not taking advantage of. This is commonly known as the "energy gap" or "energy paradox." Standard economic theory suggests that in normally functioning competitive markets, interactions between vehicle buyers and producers would lead producers to incorporate all cost-effective technology into the vehicles that they offer, without government intervention. Unlike in the light-duty vehicle market, the vast majority of vehicles in the medium- and heavy-duty truck market are purchased and operated by businesses with narrow profit margins, and for which fuel costs represent a substantial operating expense.

Even in the presence of uncertainty and imperfect information—conditions that hold to some degree in every market—we generally expect firms to attempt to minimize their costs in an effort to survive in a competitive marketplace, and therefore to make decisions that are in the best interest of the company and its owners and/or shareholders. In this case, the benefits of the rules would be due exclusively to reducing the economic costs of externalities resulting from fuel production and consumption. However, as discussed below in Section VIII.E, the agencies have estimated that the application of fuel-saving technologies in response to the proposed standards would, on average, yield private returns to truck owners of 140% to 420% (*see* Table VIII–21 below). The agencies have also estimated that the application of these technologies would be significantly lower in the absence of the proposed standards (*i.e.*, under the "no action" regulatory alternative), meaning that truck buyers and operators ignore opportunities to make investments in higher fuel economy that appear to offer significant cost savings.

There are several possible explanations in the economics literature for why trucking companies do not adopt technologies that would be expected to increase their profits: there could be a classic market failure in the trucking industry—market power, externalities, or asymmetric or incomplete (*i.e.*, missing market) information; there could be institutional or behavioral rigidities in the industry (union rules, standard operating procedures, statutory requirements, loss aversion, *etc.*), whereby participants collectively do not minimize costs; or the engineering estimates of fuel savings and costs for these technologies might overstate their benefits or understate their costs in real-world applications.

To try to understand why trucking companies have not adopted these seemingly cost-effective fuel-saving technologies, the agencies have surveyed published literature about the energy paradox, and held discussions with numerous truck market participants. Below, we have listed five categories of possible explanations derived from these sources. Collectively, these five hypotheses may explain the apparent inconsistency between the

[368] *See* Memorandum to Docket, "Economy-Wide Impacts of Proposed Heavy-Duty Truck Greenhouse Gas Emissions and Fuel Efficiency Standards", October 8, 2010. Docket EPA–HQ–OAR–2010–0162.

engineering analysis, which finds a number of cost-effective methods of improving fuel economy, and the observation that many of these technologies are not widely adopted.

These hypotheses include imperfect information in the original and resale markets, split incentives, uncertainty about future fuel prices, and adjustment and transactions costs. As the discussion will indicate, some of these explanations suggest failures in the private market for fuel-saving technology in addition to the externalities caused by producing and consuming fuel that are the primary motivation for the rules. Other explanations suggest market-based behaviors that may imply additional costs of regulating truck fuel efficiency that are not accounted for in this analysis. Anecdotal evidence from various segments of the trucking industry suggests that many of these hypotheses may play a role in explaining the puzzle of why truck purchasers appear to under-invest in fuel economy, although different explanations may apply to different segments, or even different companies. The published literature does not appear to include empirical analysis or data related to this question.

The agencies invite comment on these explanations, and on any data or information that could be used to investigate the role of any or all of these five hypotheses in explaining this energy paradox as it applies specifically to trucks. The agencies also request comment and information regarding any other hypotheses that could explain the appearance that cost-effective fuel-saving technologies have not been widely incorporated into trucks.

(1) Information Issues in the Original Sale Markets

One potential hypothesis for why the trucking industry does not adopt what appear to be inexpensive fuel saving technologies is that there is inadequate or unreliable information available about the effectiveness of many fuel-saving technologies for new vehicles. As the NAS report notes, "Reliable, peer-reviewed data on fuel saving performance is available only for a few technologies in a few applications. As a result, the committee had to rely on information from a wide range of sources, * * * including many results that have not been duplicated by other researchers or verified over a range of duty cycles." If reliable information on the effectiveness of many new technologies is absent, truck buyers will understandably be reluctant to spend additional money to purchase vehicles equipped with unproven technologies.

This lack of information can manifest itself in multiple ways. For instance, the problem may arise purely because collecting reliable information on technologies is costly (*also see* Section VIII.A.5 on transaction costs). Moreover, information has aspects of a public good, in that no single firm has the incentive to do the costly experimentation to determine whether or not particular technologies are cost-effective, while all firms benefit from the knowledge that would be gained from that experimentation. Similarly, if multiple firms must conduct the same tests to get the same information, costs could be reduced by some form of coordination of information gathering.

There are several possible reasons why trucking firms may experience difficulty gathering or interpreting information about fuel-saving technologies. It may be difficult for truck drivers and fleet operators to separate the individual effects of various technologies and operating strategies from one another, particularly when they tend to be used in conjunction. It may also be difficult for truck operators to assess the applicability of even objective and reliable test results to their own specific vehicle configurations and operating practices; at the same time, the effects of specific technologies or operating practices may vary with geography, season of the year, or other factors. In highly competitive markets, any firm that conducts tests of fuel efficiency is unlikely to share results with other firms. If so, then cost-effective technological improvements may not be adopted because they cannot be reliably distinguished from inefficient technologies.

To some extent, information about the effectiveness of some selected technologies does exist, and it suggests that some technologies appear to be very cost-effective in some situations. The SmartWay Transport Partnership is a complementary partnership between EPA and the freight goods industry (shippers, truck and rail carriers, and logistics companies) whose aim is to provide better information on fuel-efficient, low-carbon technologies and operational practices to help accelerate their deployment. SmartWay initially focused on evaluating and testing technologies for use in over-the-road class 8 tractor-trailers, commonly operated by the large, national trucking fleets. For this reason, more information is available about the configuration and operation of these types of trucks. Many of the technologies that SmartWay selected for evaluation can also save fuel and reduce greenhouse gas emissions in other types of trucks and trucking operations. However, due to the wide diversity among other types of trucks and truck operations, and lack of precise information about the effectiveness of technologies in each one of these types of truck and trucking operations, it is difficult for the program to provide good information that is specific to each company. This makes it much more challenging to improve market confidence in fuel-saving technologies for these other truck types in the same way that SmartWay has done with its existing partners. SmartWay will continue to serve as a test bed for emerging technologies and as a conduit for technical information by developing and sharing information on other types of medium- and heavy-duty vehicles, helping to build market confidence in innovative financial, technical and operational solutions for medium- and heavy-duty vehicles across the freight goods industry, and promoting retrofit fuel-saving technologies within the existing legacy fleet. Information provision, such as the efforts of the SmartWay program, is a direct, non-regulatory approach to addressing the problem of the availability and reliability of results, as long as truck purchasers are able and willing to act on the information.

While its effect on information is indirect, we expect the requirement for the use of new technologies included in this proposal will circumvent these information issues, resulting in their adoption, thus providing more readily available information about their benefits. The agencies appreciate, however, that the diversity of truck uses, driving situations, and driver behavior willl lead to variation in the fuel savings that individual trucks or fleets experience from using specific technologies.

(2) Information Issues in the Resale Market

In addition to issues in the new vehicle market, a second hypothesis for why trucking companies may not adopt what appear to be cost-effective technologies to save fuel is that the resale market may not reward the addition of fuel-saving technology to vehicles adequately to ensure their original purchase by new truck buyers. This inadequate payback for users beyond the original owner may contribute to the short payback period that new purchasers appear to expect.[369] The agencies seek data and information on the extent to which costs of fuel-

[369] *See* NAS 2010, Note 111, at p. 188.

saving equipment can be recovered in the resale truck market.

Some of this unwillingness to pay for fuel-saving technology may be due to the extension of the information problems in the new vehicle market into resale markets. Buyers in the resale market have no more reason to trust information on fuel-saving technologies than buyers in the original market. Because actual fuel economy of trucks on the road depends on many factors, including geography and driving styles or habits, even objective sources such as logs of truck performance for used vehicles may not provide reliable information about the fuel economy that potential purchasers of used trucks will experience.

A related possibility is that vehicles will be used for different purposes by their second owners than those for which they were originally designed. For instance, a vehicle originally purchased for long hauls might be used by its second owner instead for regional or intrastate trips, in which case some of the fuel-saving measures that proved effective in its original use may not be equally effective in these new uses. If information were more widely available and reliable, then purchasers in the resale market would seek vehicles with technologies that best suited their purposes, and buyers would be matched with sellers so that used vehicles would be used primarily for purposes in which their fuel-saving technologies were most valuable.

It is also possible, though, that the fuel savings experienced by the secondary purchasers may not match those experienced by their original owners if the optimal secondary new use of the vehicle does not earn as many benefits from the technologies. In that case, the premium for fuel-saving technology in the secondary market should accurately reflect its value to potential buyers participating in that market, even if it is lower than its value in the original market, and the market has not failed. Because the information necessary to optimize use in the secondary market may not be readily available or reliable, however, buyers in the resale market may have less ability than purchasers of new vehicles to identify and gain the advantages of new fuel-saving technologies, and may thus be even less likely to pay a premium for them.

For these reasons, purchasers' willingness to pay for fuel-economy technologies may be even lower in the resale market than in the original equipment market. Even when fuel-saving technologies will provide benefits in the resale markets, purchasers of used vehicles may not be willing to compensate their original owners fully for their remaining value. As a result, the purchasers of original equipment may expect the resale market to provide inadequate appropriate compensation for the new technologies, even when those technologies would reduce costs for the new buyers. This information issue may partially explain what appears to be the very short payback periods required for new technologies in the new vehicle market.

(3) Split Incentives in the Medium- and Heavy-Duty Truck Industry

A third hypothesis explaining the energy paradox as applied to trucking involves split incentives. When markets work effectively, signals provided by transactions in one market are quickly transmitted to related markets and influence the decisions of buyers and sellers in those related markets. For instance, in a well-functioning market system, changes in the expected future price of fuel should be transmitted rapidly to those who purchase trucks, who will then reevaluate the amount of fuel-saving technology to purchase for new vehicles. If for some reason a truck purchaser will not be directly responsible for future fuel costs, or the individual who will be responsible for fuel costs does not decide which truck characteristics to purchase, then those price signals may not be transmitted effectively, and incentives can be described as "split."

One place where such a split may occur is between the owners and operators of trucks. Because they are generally responsible for purchasing fuel, truck operators have strong incentives to economize on its use, and are thus likely to support the use of fuel-saving technology. However, the owners of trucks or trailers are often different from operators, and may be more concerned about their longevity or maintenance costs than about their fuel efficiency when purchasing vehicles. As a result, capital investments by truck owners may be channeled into equipment that improves vehicles' durability or reduces their maintenance costs, rather than into fuel-saving technology. If operators can choose freely among the trucks they drive, competition among truck owners to employ operators would encourage owners to invest in fuel-saving technology. However, if truck owners have more ability to choose among operators, then market signals for improved fuel savings that would normally be transmitted to truck owners may be muted.

Anecdotal information about large truck fleets suggests that, even within a company, the office or department responsible for truck purchases is often different from that responsible for purchasing fuel. Therefore, the employees who purchase trucks may have strong incentives to lower their initial capital cost, but not equally strong incentives to lower operating costs.

Single-wide tires, which save fuel and allow more payload (thus increasing revenue), offer another example of split incentives. They require a different driving style; those concerned about retaining drivers may resist their purchase, because drivers may not like the slightly different "feel" of wheel torque needed. Maintenance and repair staff may resist them because the tires may not be as available as they would like on the road, or they may need to change road service providers. Finally, those who resell the trucks may believe that the resale market will not value the tires. While financial pressures should provide incentives for greater coordination, especially when fuel costs are a large share of operating costs, it may be difficult institutionally to change budgeting procedures and to coordinate across offices. Thus, even within a company incentives for fuel savings may not be fully transmitted to those responsible for purchasing decisions.

In addition, the NAS report notes that split incentives can arise between tractor and trailer operators.[370] Trailers affect the fuel efficiency of shipping, but trailer owners do not face strong incentives to coordinate with truck owners. Although some trucking fleets own or lease their own trailers, a significant part of the trucking business is "drop and hook" service, in which trucking fleets pick up and drop off trailers and containers. These trailers and containers can belong to shippers, other trucking companies, leasing companies, or ocean-going vessel lines, in which cases their owners may not face strong incentives to economize on fuel consumption by tractor operators. Though tractor operators should, in principle, have some ability to arrange tractor-trailer combinations that provide increased fuel efficiency, the value of the resulting fuel savings may be small relative to the complexity and cost involved. EPA and NHTSA are not proposing to regulate trailers in this proposal.

By itself, information provision may be inadequate to address the potential underinvestment in fuel economy

[370] *See* NAS 2010, Note 111, at p. 182.

resulting from such split incentives. In this setting, regulation may contribute to fuel savings that otherwise may be difficult to achieve.

The agencies seek evidence and data on the extent to which split incentives affect purchasing choices in truck markets. For example, are trailer buyers that do not own their own tractors less likely to purchase aerodynamic trailers than those that purchase and drive both tractors and trailers?

(4) Uncertainty About Future Cost Savings

Another hypothesis for the lack of adoption of seemingly fuel saving technologies may be uncertainty about future fuel prices or truck maintenance costs. When purchasers have less than perfect foresight about future operating expenses, they may implicitly discount future savings in those costs due to uncertainty about potential returns from investments that reduce future costs. In contrast, the immediate costs of the fuel-saving or maintenance-reducing technologies are certain and immediate, and thus not subject to discounting. In this situation, both the expected return on capital investments in higher fuel economy and potential variance about its expected rate may play a role in a firm's calculation of its payback period on such investments.

In the context of energy efficiency investments for the home, Metcalf and Rosenthal (1995) and Metcalf and Hassett (1995) observe that households weigh known, up-front costs that are essentially irreversible against an unknown stream of future fuel savings.[371] Uncertainty about the value of future energy savings may make risk-averse households reluctant to invest in energy-saving technologies that appear to offer attractive economic returns. These authors find that it is possible to replicate the observed adoption rates for household energy efficiency improvements by incorporating the effect of uncertainty about the value of future energy savings into an empirical model. Notably, in this situation, requiring households to adopt technologies more quickly may make them worse off by imposing additional risk on them.

Greene *et al.* (2009) also find support for this explanation in the context of light-duty fuel economy decisions: a loss-averse consumer's expected net present value of increasing the fuel economy of a passenger car can be very close to zero, even if a risk-neutral expected value calculation shows that its buyer can expect significant net benefits from purchasing a more fuel-efficient car.[372] These authors note that uncertainty regarding the future price of gasoline is a less important source of this result than is uncertainty about the lifetime, expected use, and reliability of the vehicle. Supporting this hypothesis is a finding by Dasgupta *et al.* (2007) that consumers are more likely to lease than buy a vehicle with higher maintenance costs because it provides them with the option to return it before those costs become too high.[373] However, the agencies know of no studies that have estimated the impact of uncertainty on perceived future savings for medium- and heavy-duty vehicles.

Purchasers' uncertainty about future fuel prices implies that mandating improvements in fuel efficiency can reduce the expected utility associated with truck purchases. This is because adopting such regulation requires purchasers to assume a greater level of risk than they would in its absence, even if the future fuel savings predicted by a risk-neutral calculation actually materialize. Thus the mere existence of uncertainty about future savings in fuel costs does not by itself assure that regulations requiring improved fuel efficiency will necessarily provide economic benefits for truck purchasers and operators. On the other hand, because risk aversion reduces expected returns for businesses, competitive pressures can reduce risk aversion: risk-neutral companies can make higher average profits over time. Thus, significant risk aversion is unlikely to survive competitive pressures.

(5) Adjustment and Transactions Costs

Another hypothesis is that transactions costs of changing to new technologies (how easily drivers will adapt to the changes, *e.g.*) may slow or prevent their adoption. Because of the diversity in the trucking industry, truck owners and fleets may like to see how a new technology works in the field, when applied to their specific operations, before they adopt it. If a conservative approach to new technologies leads truck buyers to adopt new technologies slowly, then successful new technologies are likely to be adopted over time without market intervention, but with potentially significant delays in achieving fuel saving, environment, and energy security benefits.

In addition, there may be costs associated with training drivers to realize the 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 new fuel-saving technologies. Here, again, there may be no market failure; requiring the widespread use of these technologies may impose adjustment and transactions costs not included in this analysis. As in the discussion of the role of risk, these adjustment and transactions costs are typically immediate and undiscounted, while their benefits are future and uncertain; risk or loss aversion may further discourage companies from adopting new technologies.

To the extent that there may be transactions costs associated with the new technologies, then regulation gives all new truck purchasers a level playing field, because it will require all of them to adjust on approximately the same time schedule. If experience with the new technologies serves to reduce uncertainty and risk, the industry as a whole may become more accepting of new technologies. This could increase demand for future new technologies and induce additional benefits in the legacy fleet through complementary efforts such as SmartWay.

(6) Summary

On the one hand, commercial vehicle operators are under competitive pressure to reduce operating costs, and thus their purchasers would be expected to pursue and rapidly adopt cost-effective fuel-saving technologies. On the other hand, the short payback period required by buyers of new trucks is a symptom that suggests some combination of uncertainty about future cost savings, transactions costs, and imperfectly functioning markets. In addition, widespread use of tractor-trailer combinations introduces the possibility that owners of trailers may have weaker incentives than truck owners or operators to adopt fuel-saving technology for their trailers. The market

[371] Metcalf, G., and D. Rosenthal (1995). "The 'New' View of Investment Decisions and Public Policy Analysis: An Application to Green Lights and Cold Refrigerators," Journal of Policy Analysis and Management 14: 517–531. Hassett and Metcalf (1995). "Energy Tax Credits and Residential Conservation Investment: Evidence from Panel Data" Journal of Public Economics 57 (1995): 201–217. Metcalf, G., and K. Hassett (1999). "Measuring the Energy Savings from Home Improvement Investments: Evidence from Monthly Billing Data." The Review of Economics and Statistics 81(3): 516–528.

[372] Greene, D., J. German, and M. Delucchi (2009). "Fuel Economy: The Case for Market Failure" in Reducing Climate Impacts in the Transportation Sector, Sperling, D., and J. Cannon, eds. Springer Science.

[373] Dasgupta, S., S. Siddarth, and J. Silva-Risso (2007). "To Lease or to Buy? A Structural Model of a Consumer's Vehicle and Contract Choice Decisions." Journal of Marketing Research 44: 490–502.

for medium- and heavy-duty trucks may face these problems, both in the new vehicle market and in the resale market.

Provision of information about fuel-saving technologies through voluntary programs such as SmartWay will assist in the adoption of new cost-saving technologies, but diffusion of new technologies can still be obstructed. Those who are willing to experiment with new technologies expect to find cost savings, but those may be difficult to prove. As noted above, because individual results of new technologies vary, new truck purchasers may find it difficult to identify or verify the effects of fuel-saving technologies. Those who are risk-averse are likely to avoid new technologies out of concerns over the possibility of inadequate returns on the investment, or with other adverse impacts. Competitive pressures in the freight transport industry can provide a strong incentive to reduce fuel consumption and improve environmental performance. However, not every driver or trucking fleet operating today has the requisite ability or interest to access the technical information, some of which is already provided by SmartWay, nor the resources necessary to evaluate this information within the context of his or her own freight operation.

As noted at the beginning of this section, the agencies seek comments on all these hypotheses as well as any data that could inform our understanding of what appears to be slow adoption of cost-effective fuel-saving technologies in these industries.

B. Costs Associated With the Proposed Program

In this section, the agencies present the estimated costs associated with the proposed program. The presentation here summarizes the costs associated with new technology expected to be added to meet the new GHG and fuel consumption standards. The analysis summarized here provides the estimate of incremental costs on a per truck basis and on an annual total basis.

The presentation here summarizes the best estimate by EPA and NHTSA staff as to the technology mix expected to be employed for compliance. For details behind the cost estimates associated with individual technologies, the reader is directed to Section III of this preamble and to Chapter 2 of the draft RIA.

With respect to the cost estimates presented here, the agencies note that, because these estimates relate to technologies which are in most cases already available, these cost estimates are technically robust.

(1) Costs per Truck

For the Class 2b and 3 pickup trucks and vans, the agencies have used a methodology consistent with that used for our recent light-duty joint rulemaking since most of the technologies expected for Class 2b and 3 pickup trucks and vans is consistent with that expected for the larger light-duty trucks. The cost estimates presented in the recent light-duty joint rulemaking were then scaled upward to account for the larger weight, towing capacity, and work demands of the trucks in these heavier classes. For details on that scaling process and the resultant costs for individual technologies, the reader is directed to Section III of this preamble and to Chapter 2 of the draft RIA. Note also that all cost estimates have been updated to 2008 dollars for this analysis while the recent light-duty joint rulemaking was presented in 2007 dollars.

For the loose heavy-duty gasoline engines, we have generally used engine-related costs from the Class 2b and 3 pickup truck and van estimates since the loose heavy-duty gasoline engines are essentially the same engines as those sold into the Class 2b and 3 pickup truck and van market.

For heavy-duty diesel engines, the agencies have estimated costs using a different methodology than that employed in the recent light-duty joint rulemaking. In the recent light-duty joint rulemaking, the fixed costs were included in the hardware costs via an indirect cost multiplier. As such, the hardware costs presented in that analysis, and in the cost estimates for Class 2b and 3 trucks, included both the actual hardware and the associated fixed costs. For this analysis, some of the fixed costs are estimated separately for HD diesel engines and are presented separately from the hardware costs. For details, the reader is directed to Chapter 2 of the draft RIA. Importantly, both methodologies after the figures are totaled account for all the costs associated with the proposal. As noted above, all costs are presented in 2008 dollars.

The estimates of vehicle compliance costs cover the years leading up to—2012 and 2013—and including implementation of the program—2014 through 2018. Also presented are costs for the years following implementation to shed light on the long term (2022 and later) cost impacts of the program. The year 2022 was chosen here consistent with the recent light-duty joint rulemaking. That year was considered long term in that analysis because the short-term and long-term markup factors described shortly below are applied in five year increments with the 2012 through 2016 implementation span and the 2017 through 2021 span both representing the short-term. Since many of the costs used in this analysis are based on costs in the recent light-duty joint rulemaking analysis, consistency with that analysis seems appropriate. That said, comments are requested as to whether a different year would be a more appropriate long term year.

Some of the individual technology cost estimates are presented in brief in Section III, and account for both the direct and indirect costs incurred in the manufacturing and dealer industries (for a complete presentation of technology costs, please refer to Chapter 2 of the draft RIA). To account for the indirect costs on Class 2b and 3 pickup trucks and vans, the agencies have applied an ICM factor to all of the direct costs to arrive at the estimated technology cost. The ICM factor used was 1.17 in the short-term (2014 through 2021) to account for differences in the levels of R&D, tooling, and other indirect costs that will be incurred. Once the program has been fully implemented, some of the indirect costs will no longer be attributable to these standards and, as such, a lower ICM factor is applied to direct costs in 2022 and later. The agencies have also applied ICM factors to Class 4 through 8 trucks and to heavy-duty diesel engine technologies. Markup factors in these categories range from 1.11 to 1.26 in the short term (2014 through 2021) depending on the complexity of the given technology. Note that, for the HD diesel engines, the agencies have applied these mark ups to ensure that our estimates are conservative since we have estimated fixed costs separately for technologies applied to these categories—effectively making the use of markups a double counting of indirect costs. The agencies request comment on whether this approach is overly conservative. The agencies also request comment on the ICMs being used in this analysis—the levels associated with R&D, warranty, *etc.*—and whether those are appropriate or should be revised. If commenters suggest revisions, the agencies request supporting arguments and/or documentation. For the details on the ICMs, please refer to the report that has been placed in the docket for this proposal.[374]

The agencies have also considered the impacts of manufacturer learning on the

[374] RTI International. Heavy-duty Truck Retail Price Equivalent and Indirect Cost Multipliers. July 2010.

technology cost estimates by reflecting the phenomenon of volume-based learning curve cost reductions in our modeling using two algorithms—"volume-based" for newer technologies and "time-based" for mature technologies. The observed phenomenon in the economic literature which supports manufacturer learning cost reductions are based on reductions in costs as production volumes increase, and the economic literature suggests these cost reductions occur indefinitely, though the absolute magnitude of the cost reductions decrease as production volumes increase (with the highest absolute cost reduction occurring with the first doubling of production). The agencies use the terminology "volume-based" and "time-based" to distinguish among newer technologies and more mature technologies, respectively, and how learning cost reductions are applied in cost analyses. The volume-based learning algorithm applies for the early, steep portion of the learning curve and is estimated to result in 20 percent lower costs after two full years of implementation (*i.e.,* a 2016 MY cost would be 20 percent lower than the 2014 and 2015 model year costs for a new technology being implemented in 2014). The time-based learning algorithm applies for the flatter portion of the learning curve and is estimated to result in 3 percent lower costs in each of the five years following first introduction of a given technology. Once two volume-based learning steps have occurred (for technologies having volume-based learning applied), time based learning would begin. For technologies to which time based learning is applied, learning would begin in year 2 at 3 percent per year for 5 years. Beyond 5 years of time-based learning at 3 percent per year, 5 years of time-based learning at 2 percent per year, then 5 at 1 percent per year become effective.

Learning impacts have been considered on most but not all of the technologies expected to be used because some of the expected technologies are already used rather widely in the industry and, presumably, learning impacts have already occurred. The agencies have applied the volume-based learning algorithm for only a handful of technologies considered to be new or emerging technologies such as energy recovery systems and thermal storage units which might one day be used on big trucks. For most technologies, the agencies have considered them to be more established and, hence, the agencies have applied the lower time-based learning algorithm. For more discussion of the learning approach and the technologies to which each type of learning has been applied the reader is directed to Chapter 2 of the draft RIA.

In past rulemakings that have made use of these learning curve effects, comments have been received from industry related to learning effects. Commenters have stated that firms think of learning in terms of time, not production or sales volume, because that is how contracts are written between original equipment manufacturers and their suppliers. The agencies seek comment on whether or not learning is being considered properly in our analyses—is it appropriate to consider time-based learning on technologies that are already in the marketplace, or should the assumption be that such learning is already considered in the cost estimates we use? Similarly, while the agencies firmly believe that learning continues to occur given the level of ingenuity in the industries we regulate, we want to know more about whether it is appropriate for the agencies to consider the learning in our cost estimates or to consider all costs to be long-term, fully learned costs. The agencies seek not only comment on this issue but supporting information regarding learning effects and how learning is accounted for in cost contracts between supplying and purchasing firms.

The technology cost estimates discussed in Section III and detailed in Chapter 2 of the draft RIA are used to build up technology package cost estimates. For each engine and truck class, a single package for each was developed capable of complying with the proposed standards and the costs for each package was generated. The technology packages and package costs are discussed in more detail in Chapter 2 of the draft RIA. The compliance cost estimates take into account all credits and trading programs and include costs associated with air conditioning controls. Table VIII–1 presents the average incremental costs per truck for this proposal. For HD pickup trucks and vans (Class 2b and 3), costs increase as the standards become more stringent in 2014 through 2018. Following 2018, costs then decrease going forward as learning effects result in decreased costs for individual technologies. By 2022, the long term ICMs take effect and costs decrease yet again. For vocational vehicles, cost trends are more difficult to discern as diesel engines begin adding technology in 2014, gasoline engines begin adding technology in 2016, and the trucks themselves begin adding technology in 2014. With learning effects the costs, in general, decrease each year except for the heavy-duty gasoline engine changes in 2016. Long term ICMs take effect in 2022 to provide more cost reductions. For combination tractors, costs generally decrease each year due to learning effects with the exception of 2017 when the engines placed in sleeper cab tractors add turbo compounding. Following that, learning impacts result in cost reductions and the long term ICMs take effect in 2022 for further cost reductions. By 2030 and later, cost per truck estimates remain constant for all classes. Regarding the long term ICMs taking effect in 2022, the agencies consider this the point at which some indirect costs decrease or are no longer considered attributable to the program (*e.g.,* warranty costs go down). Costs per truck remain essentially constant thereafter.

Table VIII-1: Estimated Cost per Truck (2008 dollars)

	HD Pickups & Vans	Vocational	Combination
2014	$225	$374	$5,896
2015	$292	$367	$5,733
2016	$567	$400	$5,480
2017	$848	$392	$6,150
2018	$1,411	$359	$5,901
2020	$1,406	$343	$5,661
2030	$1,350	$280	$4,686
2040	$1,350	$275	$4,686
2050	$1,350	$275	$4,686

These costs would, presumably, have some impact on new truck prices, although the agencies make no attempt at determining what the impact of increased costs would be on new truck prices. Nonetheless, on a percentage basis, the costs shown in Table VIII–1 for 2018 MY trucks (when all proposed requirements are fully implemented) would be roughly four percent for a typical HD pickup truck or van, less than one percent for a typical vocational vehicle, and roughly six percent for a typical combination truck/tractor using new truck prices of $40,000, $100,000 and $100,000, respectively. The costs would represent lower or higher percentages of new truck prices for new trucks with higher or lower prices, respectively. Given the wide range of new truck prices in these categories—a Class 4 Vocational work truck might be $40,000 when new while a Class 8 refuse truck (*i.e.,* a large vocational vehicle) might be as much as $200,000 when new—it is very difficult to reflect incremental costs as percentages of new truck prices for all trucks. What is presented here is the average cost (Table VIII–1) compared with typical new truck prices.

As noted above, the fixed costs were estimated separately from the hardware costs for HD diesel engines that are placed in vocational vehicles and combination tractors. Those fixed costs are not included in Table VIII–1. The agencies have estimated the R&D costs at $6.75 million per manufacturer per year for five years and the new test cell costs (to accommodate measurement of N_2O emissions) at $100,000 per manufacturer. These costs apply individually for LHD, MHD and HHD engines. Given the 14 manufacturers impacted by the proposed standards, 11 of which are estimated to sell both MHD and HHD engines and 3 of which are estimated to sell LHD engines, we have estimated a five year annual R&D cost of $168.8 million dollars ($2 \times 11 \times \$6.75$ million plus $3 \times \$7.75$ million for each year 2012–2016) and a one-time test cell cost of $2.5 million dollars ($2 \times 11 \times \$100,000$ plus $3 \times \$100,000$ in 2013). Estimating annual sales of HD diesel engines at roughly 600,000 units results in roughly $280 per engine per year for five years beginning in 2012 and ending in 2016. Again, these costs are not reflected in Table VIII–1, but are included in Table VIII–2 as "Other Engineering Costs."

The certification and compliance program costs, for all engine and truck types, are estimated at $4.4 million per year and are expected to continue indefinitely. These costs are detailed in the "Draft Supporting Statement for Information Collection Request" which is contained in the docket for this rule.[375] Estimating annual sales of heavy-duty trucks at roughly 1.5 million units would result in $3 per engine/truck per year. These costs are not reflected in Table VIII–1, but are included in Table VIII–2 as "Compliance Program" costs.

(2) Annual Costs of the Proposal

The costs presented here represent the incremental costs for newly added technology to comply with the proposal. Together with the projected increases in truck sales, the increases in per-truck average costs shown in Table VIII–1 above result in the total annual costs presented in Table VIII–2 below. Note that the costs presented in Table VIII–2 do not include the savings that would occur as a result of the improvements to fuel consumption. Those impacts are presented in Section VIII.E. Note also that the costs presented here represent costs estimated to occur presuming that the proposed standards will continue in perpetuity. Any future changes to the proposed standards would be considered at the time they are proposed and/or made final. In other words, the proposed standards do not apply only to 2014–2018 model year trucks—they do, in fact, apply to all 2014 and later model year trucks. We present more detail regarding the 2014–2018 model year trucks in Section VIII.K where we summarize all monetized costs and benefits.

[375] "Draft Supporting Statement for Information Collection Request," Control of Greenhouse Gas Emissions from New Motor Vehicles: Proposed Heavy-Duty Engine and Vehicle Standards, EPA ICR Tracking Number 2394.01.

Table VIII-2: Annual Costs Associated with the Proposal ($Millions of 2008 dollars)

Year	HD Pickup and Van	Vocational	Combination	Other Engineering Costs	Compliance Program Costs	Annual Costs
2012	$0	$0	$0	$169	$0	$169
2013	$0	$0	$0	$171	$4.4	$176
2014	$177	$208	$720	$169	$4.4	$1,278
2015	$213	$211	$713	$169	$4.4	$1,310
2016	$404	$237	$693	$169	$4.4	$1,507
2017	$601	$240	$792	$0	$4.4	$1,638
2018	$1,011	$226	$776	$0	$4.4	$2,019
2020	$971	$229	$777	$0	$4.4	$1,981
2030	$962	$241	$742	$0	$4.4	$1,950
2040	$1,038	$332	$850	$0	$4.4	$2,224
2050	$1,119	$436	$982	$0	$4.4	$2,541
NPV, 3%	$18,770	$5,728	$16,707	$787	$98	$42,089
NPV, 7%	$9,657	$2,977	$9,114	$718	$56	$22,522

C. Indirect Cost Multipliers

(1) Markup Factors to Estimate Indirect Costs

For most of the segments in this analysis, the indirect costs are estimated by applying indirect cost multipliers (ICM) to direct cost estimates. ICMs were calculated by EPA as a basis for estimating the impact on indirect costs of individual vehicle technology changes that would result from regulatory actions. Separate ICMs were derived for low, medium, and high complexity technologies, thus enabling estimates of indirect costs that reflect the variation in research, overhead, and other indirect costs that can occur among different technologies. ICMs were also applied in the MY 2012–2016 CAFE rulemaking.

The previous CAFE rulemaking applied a retail price equivalent (RPE) factor to estimate indirect costs and mark up direct costs to the retail level. Retail Price Equivalents are estimated by dividing the total revenue of a manufacturer by the direct manufacturing costs. As such, it includes all forms of indirect costs for a manufacturer and assumes that the ratio applies equivalently for all technologies. ICMs are based on RPE estimates that are then modified to reflect only those elements of indirect costs that would be expected to change in response to a technology change. For example, warranty costs would be reflected in both RPE and ICM estimates, while marketing costs might only be reflected in an RPE estimate but not an ICM estimate for a particular technology, if the new technology is not one expected to be marketed to consumers. Because ICMs calculated by EPA are for individual technologies, many of which are small in scale, they often reflect a subset of RPE costs; as a result, the RPE is typically higher than an ICM. This is not always the case, as ICM estimates for complex technologies may reflect higher than average indirect costs, with the resulting ICM larger than the averaged RPE for the industry.

Precise association of ICM elements with individual technologies based on the varied accounting categories in company annual reports is not possible. Hence, there is a degree of uncertainty in the ICM estimates. If all indirect costs moved in proportion to changes in direct costs the ICM and RPE would be the same. Because most individual technologies are smaller scale than many of the activities of auto companies (such as designing and developing entirely new vehicles), it would be expected that the RPE estimate would reflect an upper bound on the average ICM estimate. The agencies are continuing to study ICMs and the most appropriate way to apply them, and it is possible revised ICM values may be used in our final rulemaking. With this in mind, the agencies are presenting a sensitivity analysis reflecting costs measured using the RPE in place of the ICM and indirect costs estimated independently in our primary analysis to examine the potential impact of these two approaches on estimated costs.

(2) Background

While this analysis relies on ICMs to estimate indirect costs, an alternative method of estimating indirect costs is the retail price equivalent factor. The RPE has been used by NHTSA, EPA and other agencies to account for cost factors not included in available direct cost estimates, which are derived from cost teardown studies or sometimes provided by manufacturers. The RPE is the basis for these markups in all DOT safety regulations and in most previous fuel economy rules. The RPE includes all variable and fixed elements of overhead costs, as well as selling costs such as vehicle delivery expenses, manufacturer profit, and full dealer markup, and assumes that the ratio of indirect costs to direct costs is constant for all vehicle changes. Historically, NHTSA has estimated that the RPE has averaged about 1.5 for the light-duty motor vehicle industry. The implication of an RPE of 1.5 is that each added $1.00 of variable cost in materials, labor, and other direct manufacturing costs results in an increase in consumer prices of $1.50 for any change in vehicles.

NHTSA has estimated the RPE from light-duty vehicle manufacturers' financial statements over nearly 3 decades, and although its estimated value has varied somewhat year-to-year, it has generally hovered around a level of 1.5 throughout most of this period. The NAS report as well as a study by RTI International found that other estimates of the RPE varied from 1.26 to over 2.[376] In a recent report, NAS acknowledged that an ICM approach was preferable but recommended continued use of the RPE over ICMs until such time as empirical data derived from rigorous estimation methods is available. The NAS report recommended using an RPE of 1.5 for outsourced (supplier manufactured) and 2.0 for in-house (OEM manufactured) technologies and an RPE of 1.33 for advanced hybrid and electric vehicle technologies.

ICMs typically are significantly lower than RPEs, because they measure changes in only those elements of overhead and selling-related costs that are directly influenced by specific technology changes to vehicles. For example, the number of managers might not be directly proportional to the value of direct costs contained in a vehicle, so that if a regulation increases the direct costs of manufacturing vehicles, there might be little or no change in the number of managers. ICMs would thus assume little or no change in that portion of indirect costs associated with the number of managers—these costs would be allocated only to the existing base vehicle. By contrast, the RPE reflects the historical overall relationship between the direct costs to manufacture vehicles and the prices charged for vehicles, which must compensate manufacturers for both their direct and indirect costs for producing and selling vehicles. The assumption behind the RPE is that changes in the long-term price of the final product that accompany increases in direct costs of vehicle manufacturing will continue to reflect this historical relationship.

Another difference between the RPE and ICM is that ICMs have been derived separately for different categories of technologies. A relatively simple technology change, such as switching to a different tire with lower rolling resistance characteristics, would not influence indirect costs in the same proportion as a more complex change, such as development of a full hybrid design. ICMs were developed for 3 broad categories of technology complexities, and are applied separately to fuel economy technologies judged to fit into each of these categories. This requires determining which of these complexity categories each technology should be assigned.

There is some level of uncertainty surrounding both the ICM and RPE markup factors. The ICM estimates used in this proposal group all technologies into three broad categories and treat them as if individual technologies within each of the three categories (low, medium, and high complexity) would have the same ratio of indirect costs to direct costs. This simplification means it is likely that the direct cost for some technologies within a category will be higher and some lower than the estimate for the category in general. More importantly, the ICM estimates have not been validated through a direct accounting of actual indirect costs for individual technologies. Rather, the ICM estimates were developed using adjustment factors developed in two separate occasions: The first, a consensus process, was reported in the RTI report; The second, a modified Delphi method, was conducted separately and reported in an EPA memo.[377] Both these panels were composed of EPA staff members with previous background in the automobile industry; the memberships of the two panels overlapped but were not the same.[378] The panels evaluated each element of the industry's RPE estimates and estimated the degree to which those elements would be expected to change in proportion to changes in direct manufacturing costs. The method and estimates in the RTI report were peer reviewed by three industry experts and subsequently by reviewers for the International Journal of Production Economics.[379] RPEs themselves are inherently difficult to estimate because the accounting statements of manufacturers do not neatly categorize all cost elements as either direct or indirect costs. Hence, each researcher developing an RPE estimate must apply a certain amount of judgment to the allocation of the costs. Moreover, RPEs for heavy- and medium-duty trucks and for engine manufacturers are not as well studied as they are for the light-duty automobile industry. Since empirical estimates of ICMs are ultimately derived from the same data used to measure RPEs, this affects both measures. However, the value of RPE has not been measured for specific technologies, or for groups of specific technologies. Thus applying a single average RPE to any given technology by definition overstates costs for very simple technologies, or understates them for advanced technologies.

To highlight the potential differences between the use of ICMs and RPEs to estimate indirect costs, the agencies conducted an analysis based on the use of average RPEs for each industry in the place of the ICM and direct fixed cost estimates used in our proposal. Since most technologies involved in this proposal are low complexity level technologies, the estimate based on the use of an average RPE likely overstates the costs. The weighted average RPEs for the truck and engine industries are 1.36 and 1.28 respectively. These values were substituted for the ICMs and directly estimate indirect costs used in the primary cost analysis referenced elsewhere in this document. Using the average RPEs, the five model year cost of $7.7B in the primary analysis increases to $9.3B, an increase of 21 percent. The agencies request comment accompanied by supporting data on the use of ICMs and RPE factors to estimate fixed costs.

D. Cost per Ton of Emissions Reductions

The agencies have calculated the cost per ton of GHG reductions associated with this proposal on a CO_{2eq} basis using the above costs and the emissions reductions described in Sections VI and VII. These values are presented in Table VIII–3 through Table VIII–5 for HD pickups and vans, vocational vehicles and combination trucks/tractors, respectively. The cost per metric ton of GHG emissions reductions has been calculated in the years 2020, 2030, 2040, and 2050 using the annual vehicle compliance costs and emission reductions for each of those years. The value in 2050 represents the long-term cost per ton of the emissions reduced. The agencies have also calculated the cost per metric ton of GHG emission reductions including the savings associated with reduced fuel consumption (presented below in Section VIII. E.). This latter calculation does not include the other benefits associated with this proposal such as those associated with energy security benefits as discussed later in Section VIII.I. By including the fuel savings in the cost estimates, the cost per ton is generally less than $0 since the estimated value of fuel savings outweighs the program costs. The results for CO_{2eq} costs per ton under the

[376] Rogozhin, Alex, Michael Gallaher, and Walter McManus. "Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers." Report prepared for EPA by RTI International. EPA Report EPA–420–R–09–003, February 2009.

[377] Helfand, Gloria, and Sherwood, Todd. "Documentation of the Development of Indirect Cost Multipliers for Three Automotive Technologies." Memorandum, Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, August 2009.

[378] NHTSA staff participated in the development of the process for the second, modified Delphi panel, and reviewed the results as they were developed, but did not serve on the panel.

[379] The results of the RTI report were published in Alex Rogozhin, Michael Gallaher, Gloria Helfand, and Walter McManus, "Using Indirect Cost Multipliers to Estimate the Total Cost of Adding New Technology in the Automobile Industry." *International Journal of Production Economics* 124 (2010): 360–368.

proposal across all regulated categories are shown in Table VIII–6.

Table VIII-3: Annual Cost per Metric Ton of CO_2eq Reduced – HD Pickup Trucks & Vans (2008 dollars)

Year	Program Cost	Fuel Savings (post-tax)	CO_2eq Reduced	Cost per Ton (without Fuel Savings)	Cost per Ton (with Fuel Savings)
2020	$1,000	$1,000	4	$270	$0
2030	$1,000	$3,000	10	$100	-$200
2040	$1,000	$4,600	13	$70	-$270
2050	$1,100	$5,800	16	$70	-$290

Table VIII-4: Annual Cost per Metric Ton of CO_2eq Reduced – Vocational Vehicles (2008 dollars)[380]

Year	Program Cost	Fuel Savings (post-tax)	CO_2eq Reduced	Cost per Ton (without Fuel Savings)	Cost per Ton (with Fuel Savings)
2020	$200	$1,500	6	$30	-$220
2030	$200	$3,700	13	$20	-$280
2040	$300	$6,400	19	$20	-$320
2050	$400	$8,900	26	$20	-$330

Table VIII-5: Annual Cost per Metric Ton of CO_2eq Reduced – Combination Tractors (2008 dollars)[381]

Year	Program Cost	Fuel Savings (post-tax)	CO_2eq Reduced	Cost per Ton (without Fuel Savings)	Cost per Ton (with Fuel Savings)
2020	$800	$6,700	26	$30	-$230
2030	$700	$14,500	48	$10	-$280
2040	$800	$19,800	59	$10	-$320
2050	$1,000	$23,700	67	$10	-$340

Table VIII-6: Annual Cost per Metric Ton of CO_2eq Reduced – Proposal ($2008 dollars)

Year	Program Cost	Fuel Savings (post-tax)	CO_2eq Reduced	Cost per Ton (without Fuel Savings)	Cost per Ton (with Fuel Savings)
2020	$2,000	$9,300	35	$60	-$210
2030	$1,900	$21,200	71	$30	-$270
2040	$2,200	$30,800	91	$20	-$310
2050	$2,500	$38,400	109	$20	-$330

E. Impacts of Reduction in Fuel Consumption

(1) What are the projected changes in fuel consumption?

The new CO_2 standards will result in significant improvements in the fuel efficiency of affected trucks. Drivers of those trucks will see corresponding savings associated with reduced fuel expenditures. The agencies have estimated the impacts on fuel consumption for the tailpipe CO_2 standards. To do this, fuel consumption is calculated using both current CO_2 emission levels and the new CO_2 standards. The difference between these estimates represents the net savings from the CO_2 standards. Note that the total number of miles that vehicles are driven each year is different under the control case scenario than in the reference case due to the "rebound effect," which is discussed in Section VIII.E.(5). EPA also notes that drivers who drive more than our average estimates for vehicle miles traveled (VMT) will experience more fuel savings; drivers who drive less than our average VMT estimates will experience less fuel savings.

The expected impacts on fuel consumption are shown in Table VIII–7. The gallons shown in the table reflect impacts from the new CO_2 standards and include increased consumption resulting from the rebound effect.

Table VIII-7: Fuel Consumption Impacts of the Proposal (Million gallons)

Year	Gasoline	Diesel
2014	1.8	316
2015	5.2	624
2016	20	931
2017	42	1,393
2018	76	1,861
2020	140	2,723
2030	373	5,412
2040	496	7,004
2050	603	8,453

[380] The program costs, fuel savings, and CO_{2eq} reductions of the engines installed in vocational vehicles are embedded in the vehicle standards and analysis.

(2) Potential Impacts on Global Fuel Use and Emissions

EPA's quantified reductions in fuel consumption focus on the gains from reducing fuel used by heavy-duty vehicles within the United States. However, as discussed in Section VIII.I, EPA also recognizes that this regulation will lower the world price of oil (the "monopsony" effect). Lowering oil prices could lead to an uptick in oil consumption globally, leading to a corresponding increase in GHG emissions in other countries. This global increase in emissions could slightly offset some of the emission reductions achieved domestically as a result of the regulation.

EPA does not provide quantitative estimates of the impact of the regulation on global petroleum consumption and GHG emissions but invites comment on whether to consider this impact.

(3) What are the monetized fuel savings?

Using the fuel consumption estimates presented in Table VIII–7, the agencies can calculate the monetized fuel savings associated with the proposed standards. To do this, reduced fuel consumption is multiplied in each year by the corresponding estimated average fuel price in that year, using the reference case taken from the AEO 2010. These estimates do not account for the significant uncertainty in future fuel prices; the monetized fuel savings will be understated if actual fuel prices are higher (or overstated if fuel prices are lower) than estimated. 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 savings consumers would see. The pre-tax fuel savings are those savings that society would see. These results are shown in Table VIII–8. Note that in Section VIII.K, the overall benefits and costs of the rules are presented and, for that reason, only the pre-tax fuel savings are presented there. The agencies also request comment on the additional information that would be provided by conducting sensitivity analysis that considers the effect of uncertainty in future fuel prices on estimated fuel savings. For instance, the agencies could conduct sensitivity analyses by relying on the AEO 2010 low oil price and high oil price scenarios.

Table VIII-8: Estimated Monetized Fuel Savings ($Millions of 2008 dollars)

Year	Fuel Savings (pre-tax)	Fuel Savings (post-tax)
2014	$700	$800
2015	$1,400	$1,700
2016	$2,200	$2,700
2017	$3,600	$4,200
2018	$5,100	$5,900
2020	$8,100	$9,300
2030	$19,000	$21,200
2040	$28,100	$30,800
2050	$35,400	$38,400
NPV, 3%	$352,300	$391,200
NPV, 7%	$152,600	$170,600

As shown in Table VIII–8, the agencies are projecting that truck consumers would realize very large fuel savings as a result of the proposed standards. As discussed further in the introductory paragraphs of Section VIII, it is a conundrum from an economic perspective that these large fuel savings have not been provided by manufacturers and purchased by consumers of these products. Unlike in the light-duty vehicle market, the vast majority of vehicles in the medium- and heavy-duty truck market are purchased and operated by businesses; for them, fuel costs may represent substantial operating expenses. Even in the presence of uncertainty and imperfect information—conditions that hold to some degree in every market—we generally expect firms to be cost-minimizing to survive in a competitive marketplace and to make decisions that are therefore in the best interest of the company and its owners and/or shareholders.

A number of behavioral and market phenomena may lead to a disconnect between how businesses account for fuel savings in their decisions and the way in which we account for the full stream of fuel savings for these rules, including imperfect information in the original and resale markets, split incentives, uncertainty in future fuel prices, and adjustment or transactions costs (*see* Section VIII.A for a more detailed discussion). As discussed below in the context of rebound in Section VIII.E.5, the nature of the explanation for this gap may influence the actual magnitude of the fuel savings. The agencies request comment on this issue as discussed in more detail in Section VIII.A. The agencies also request comment on the interest in a sensitivity analysis that considers the role of fuel price uncertainty by considering lower and higher future fuel prices scenarios.

(4) Payback Period and Lifetime Savings on New Truck Purchases

Another factor of interest is the payback period on the purchase of a new truck that complies with the new standards. In other words, how long would it take for the expected fuel savings to outweigh the increased cost of a new vehicle? For example, a new 2018 MY HD pickup truck and van is estimated to cost $1,290 more, a vocational vehicle $332 more, and a combination tractor $5,827 more (all values are on average, and relative to the reference case vehicle) due to the addition of new GHG reducing technology. This new technology will result in lower fuel consumption and, therefore, savings in fuel expenditures. But how many months or years would pass before the fuel savings exceed the upfront costs? Table VIII–9 shows the payback period analysis for HD pickup trucks and vans. The table shows fuel consumed under the reference case and fuel consumed by a 2018 model year truck under the proposal, inclusive of fuel consumed due to rebound miles. The decrease in fuel consumed under the proposal is then monetized by multiplying by the fuel price reported by AEO (reference case) for 2018 and later. This value represents the fuel savings expected under the proposal for an HD pickup or van. These savings are then discounted each year since future savings are considered to be of less value than current savings. Shown next are estimated increased costs (costs do not necessarily reflect increased prices which may be higher or lower than costs) for the new truck (refer to Table VIII–1). The next columns show the period required for the fuel savings to exceed the new truck costs. As seen in the table, in the fifth year of ownership, the discounted fuel savings (at both 3% and 7% discount rates) have begun to outweigh the increased cost of the truck. As shown in the table, the full life savings using 3% discounting would be $2,590 and at 7% discounting would be $1,620.

Costs in this section are shown from the greenhouse gas perspective where fuel savings are treated as negative costs, since the primary motivations of this rule are U.S. energy security and reductions in GHG emissions. From that perspective, the benefits of the rule are the external effects, and the net effects on truck owners and operators are the costs. EPA prefers to account for all costs (positive and negative) directly realized by the end user to accurately present the total cost and to differentiate those costs and cost savings from more generally realized societal benefits. At the end of this section (Section VIII.L), however, the agencies also present summary tables that show the cost and benefit analysis from the fuel efficiency perspective, where the purpose of a program to regulate fuel efficiency is primarily to save fuel. From this perspective, fuel savings would be counted as benefits that occur over the lifetime of the vehicle as it consumes less fuel, rather than as negative costs that would be experienced either at the time of purchase or over the lifetime of the vehicle. OMB's Circular A–4, which provides guidance to Federal agencies on the development of regulatory analysis, makes clear that either approach is acceptable.

Table VIII-9: Payback Period for a 2018 Model Year HD Pickup or Van (2008$)

Year of Ownership	Fuel Use (gallons)		Fuel Savings[a]		Increased Cost	Cumulative Savings	
	Reference Case	Proposal[b]	3% Discount	7% Discount		3% Discount	7% Discount
1	946	835	$334	$328	-$1,411	-$1,077	-$1,083
2	929	819	$328	$310		-$749	-$773
3	908	801	$321	$292		-$427	-$481
4	881	777	$310	$271		-$118	-$209
5	847	748	$297	$250		$179	$41
6	808	713	$279	$226		$458	$267
7	763	673	$259	$202		$717	$469
Full Life	12,439	10,976	$3,996	$3,033	-$1,411	$2,585	$1,622

Notes:

[a] Fuel savings calculated using the AEO 2010 reference case fuel prices. Gasoline and diesel fuel prices have been weighted by gasoline and diesel fuel reductions estimated for all 2018 MY heavy-duty trucks during their lifetimes.

[b] Gallons under the proposal case include gallons consumed during rebound driving.

The story is somewhat different for vocational vehicles and combination tractors. These cases are shown in Table VIII–10 and Table VIII–11, respectively. Since these trucks travel more miles in a given year, their payback periods are much shorter and actually are expected to occur within the first year of ownership under both the 3% and 7% discounting cases. As can be seen in Table VIII–10 and Table VIII–11, the lifetime fuel savings are estimated to be considerable with savings of $4,000 (3%) and $3,100 (7%) for the vocational vehicles and over $74,000 (3%) and $58,000 (7%) for the combination tractors.

Table VIII-10: Payback Period for a 2018 Model Year Vocational Vehicle (2008$)

Year of Ownership	Fuel Use (gallons)		Fuel Savings[a]		Increased Cost	Cumulative Savings	
	Reference Case	Proposal[b]	3% Discount	7% Discount		3% Discount	7% Discount
1	2,103	1,938	$497	$488	-$359	$138	$129
2	1,927	1,775	$455	$430		$593	$559
3	1,764	1,625	$417	$379		$1,010	$938
4	1,609	1,483	$378	$331		$1,387	$1,268
5	1,456	1,342	$340	$287		$1,727	$1,555
6	1,310	1,207	$301	$244		$2,029	$1,799
7	1,183	1,090	$267	$209		$2,296	$2,008
Full Life	20,144	18,572	$4,360	$3,425	-$359	$4,002	$3,066

Notes:

[a] Fuel savings calculated using the AEO 2010 reference case fuel prices. Gasoline and diesel fuel prices have been weighted by gasoline and diesel fuel reductions estimated for all 2018 MY heavy-duty trucks during their lifetimes.

[b] Gallons under the proposal case include gallons consumed during rebound driving.

Table VIII-11: Payback Period for a 2018 Model Year Combination Tractor (2008$)

Year of Ownership	Fuel Use (gallons)		Fuel Savings[a]		Increased Cost	Cumulative Savings	
	Reference Case	Proposal[b]	3% Discount	7% Discount		3% Discount	7% Discount
1	30,257	27,011	$9,746	$9,567	-$5,901	$3,845	$3,665
2	27,801	24,814	$8,968	$8,473		$12,812	$12,139
3	25,415	22,681	$8,222	$7,479		$21,035	$19,618
4	23,049	20,566	$7,425	$6,501		$28,460	$26,119
5	20,652	18,425	$6,635	$5,592		$35,096	$31,711
6	18,353	16,371	$5,819	$4,721		$40,914	$36,432
7	16,325	14,559	$5,091	$3,976		$46,005	$40,409
Full Life	261,897	233,569	$79,699	$64,023	-$5,901	$73,798	$58,122

Notes:

[a] Fuel savings calculated using the AEO 2010 reference case fuel prices. Gasoline and diesel fuel prices have been weighted by gasoline and diesel fuel reductions estimated for all 2018 MY heavy-duty trucks during their lifetimes.

[b] Gallons under the proposal case include gallons consumed during rebound driving.

All of these payback analyses include fuel consumed during rebound VMT in the proposal or control case but not in the reference case, consistent with other parts of the analysis. Further, this analysis does not include other societal impacts such as reduced time spent refueling or noise, congestion and accidents since the focus is meant to be on those factors buyers think about most while considering a new truck purchase. Note also that operators that drive more miles per year than the average would realize greater fuel savings than estimated here, and those that drive fewer miles per year would realize lesser savings. The same holds true for operators that keep their vehicles longer (*i.e.*, more years) than average in that they would realize greater lifetime fuel savings than operators that keep their vehicles for fewer years than average. Likewise, should fuel prices be higher than the AEO 2010 reference case, operators will realize greater fuel savings than estimated here while they would realize lesser fuel savings were fuel prices to be lower than the AEO 2010 reference case.

(5) Rebound Effect

The VMT rebound effect refers to the fraction of fuel savings expected to result from an increase in fuel efficiency that is offset by additional vehicle use. If truck shipping costs decrease as a result of lower fuel costs, an increase in truck VMT may occur. Unlike the light-duty rebound effect, the medium-duty and heavy-duty rebound effect has not been extensively studied. Because the factors influencing the medium- and heavy-duty rebound effect are generally different from those affecting the light-duty rebound effect, much of the research on the light-duty rebound effect is not likely to apply to the medium- and heavy-duty sectors. One of the major differences between the medium- and heavy-duty rebound effect and the light-duty rebound effect is that heavy-duty trucks are used primarily for commercial and business purposes. Since these businesses are profit driven, decision makers are highly likely to be aware of the costs and benefits of different shipping decisions, both in the near term and long term. Therefore, shippers are much more likely to take into account changes in the overall operating costs per mile when making shipping decisions that affect VMT.

Another difference from the light-duty case is that, as discussed in the recent NAS Report [382], when calculating the percentage change in trucking costs to determine the rebound effect, all changes in the operating costs should be considered. The cost of labor and fuel generally constitute the top two shares of truck operating costs, depending on the price of petroleum,[383] distance traveled, type of truck, and commodity.[384] Finally, the equipment costs associated with the purchase or leasing of the truck is also a significant component of total operating costs. Even though vehicle costs are lump-sum purchases, they can be considered operating costs for trucking firms, and these costs are, in many cases, expected to be passed onto the final consumers of shipping services on a variable basis. This shipping cost increase could help temper the rebound effect relative to the case of light-duty vehicles, in which vehicle costs are not considered operating costs.

When calculating the net change in operating costs, both the increase in new vehicle costs and the decrease in fuel costs per mile should be taken into consideration. The higher the net cost savings, the higher the expected rebound effect. Conversely, if the upfront vehicle costs outweighed future cost savings and total costs increased, shipping costs would rise, which would likely result in a decrease in truck VMT. In theory, other changes such as maintenance costs and insurance rates would also be taken into account, although information on these potential cost changes is extremely limited. We invite comment on the most appropriate methodology for factoring new vehicle purchase or leasing costs into the per-mile operating costs. We also invite comment or data on how these regulations could affect maintenance, insurance, or other operating costs.

The following sections describe the factors affecting the rebound effect, different methodologies for estimating the rebound effect, and examples of different estimates of the rebound effect to date. According to the NAS study, it is "not possible to provide a confident measure of the rebound effect," yet NAS concluded that a rebound effect likely exists and that "estimates of fuel savings from regulatory standards will be somewhat misestimated if the rebound effect is not considered." While we believe the medium- and heavy-duty rebound effect needs to be studied in more detail, we have attempted to capture the potential impact of the rebound effect in our analysis. For this proposal, we have used a rebound effect for vocational vehicles of 15%, a rebound effect for HD pickup trucks and vans of 10%, and a rebound effect for combination tractors of 5%. These VMT impacts are reflected in the estimates of total GHG and other air pollution reductions presented in Chapter 5 of the draft RIA. We invite comment and the submission of additional data on the medium-duty and heavy-duty rebound effect.

(a) Factors Affecting the Magnitude of the Rebound Effect

The heavy-duty vehicle rebound effect is driven by the interaction of several different factors. In the short-run, decreasing the fuel cost per mile of driving could lead to a decrease in end product prices. Lower prices could stimulate additional demand for those products, which would then result in an increase in VMT. In the long run, shippers could reorganize their logistics and distribution networks to take advantage of lower truck shipping costs. For example, shippers may shift away from other modes of shipping such as rail, barge, or air. In addition, shippers may also choose to reduce the number of warehouses, reduce load rates, and make smaller, more frequent shipments, all of which could also lead to an increase in heavy-duty VMT. Finally, the benefits of the fuel savings could ripple through the economy, which could in turn increase overall demand for goods and services shipped by trucks, and therefore increase truck VMT.

Conversely, if a fuel economy regulation leads to net increases in the cost of trucking because fuel savings do not fully offset the increase in upfront vehicle costs, then the price of trucking services could rise, spurring a decrease in heavy-duty VMT and shift to rail shipping. These effects would also ripple through the economy.

Because these factors have not been well studied to date, the interaction and potential magnitude of these impacts is not well understood. However, the rebound effect is one of the determinants of the fuel savings likely to result from adopting stricter fuel economy or GHG emissions standards, and is thus an important parameter affecting EPA's evaluation of alternative standards for future model years. Therefore, we invite submission of data regarding the medium- and heavy-duty rebound effect.

(b) Options for Quantifying the Rebound Effect

As described in the previous section, the fuel economy rebound effect for heavy-duty trucks has not been studied as extensively as the rebound effect for light-duty vehicles, and virtually no research has been conducted on the HD pickup truck and van rebound effect. In this proposal, we discuss four options for quantifying the rebound effect. We invite comment on these options, and we also welcome comment on other possible methodologies.

(i) Aggregate Estimates

The aggregate approximation approach quantifies the overall change in truck VMT as a result of a percentage change in truck shipping prices. This approach relies on estimates of aggregate price elasticity of demand for trucking services, given a percentage change in trucking prices, which is generally referred to as an "own-price elasticity." Estimates of trucking own-price elasticities vary widely, and there is no general consensus on the most appropriate values to use. A 2004 literature survey cited in the recent NAS report [385] found aggregate elasticity estimates in the range of −0.5 to −1.5.[386] In other words, given an own-price elasticity of −1.5, a 10% decrease in trucking prices leads to a 15% increase in demand for truck shipping demand. However, this survey does not

[382] *See* NAS Report, Note 111.

[383] American Transportation Research Institute, *An Analysis of the Operational Costs of Trucking*, December 2008 (Docket ID: EPA–HQ–OAR–2010–0162–0007).

[384] 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–2010–0162–0006). *See also* ATRI, 2008.

[385] *See* 2010 NAS Report, Note 111.

[386] Graham and Glaister, "Road Traffic Demand Elasticity Estimates: A Review," Transport Reviews Volume 24, 3, pp. 261–274, 2004 (Docket ID: EPA–HQ–OAR–2010–0162–0005).

differentiate between studies that quantify change in tons shipped or ton-miles. In addition, most of the studies find that these elasticity estimates vary substantially based on the length of the trip and the type of cargo. For example, one study estimated an own-price elasticity of −0.1 for the lumber sector and −2.3 for the chemical sector.[387]

The increase in overall truck VMT resulting from the rebound effect implicitly includes some component of mode shifting. Since there are differences in GHG emissions per ton of freight moved by rail compared to truck, any potential shifting of freight from one mode to the other could have GHG impacts. Although the total demand for freight transport is generally determined by economic activity, there is often the choice of shipping by either truck or by rail when freight is transported over land routes. This is because the United States has both an extensive highway network and an extensive rail network; these networks closely parallel each other and are often both viable choices for freight transport for many origin and destination pairs within the continent. If rates go down for one mode, there will be an increase in demand for that mode and some demand will be shifted from other modes. This "cross-price elasticity" is a measure of the percentage change in demand for shipping by another mode (*e.g.,* rail) given a percentage change in the price of trucking. Aggregate estimates of cross-price elasticities also vary widely, and there is no general consensus on the most appropriate value to use for analytical purposes. The NAS report cites values ranging from 0.35 to 0.59.[388] Other reports provide significantly different cross-price elasticities, ranging from 0.1 [389] to 2.0.[390]

When considering intermodal shift, the most relevant kinds of shipments are those that are competitive between rail and truck modes. These trips include long-haul shipments greater than 500 miles, which weigh between 50,000 and 80,000 pounds (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 truck and rail modes, and they would not be expected to shift modes except under an extreme price change. However, the total volume of ton-miles that could potentially be subject to mode shifting has also not been studied extensively.

(ii) Sector-Specific Estimates

Given the limited data available regarding the medium- and heavy-duty rebound effect, the aggregate approach greatly simplifies many of the assumptions associated with calculations of the rebound effect. In reality, however, responses to changes in fuel efficiency and new vehicle costs will vary significantly based on the commodities affected. A detailed, sector-specific approach would be expected to more accurately reflect changes in the trucking market given these standards. For example, input-output tables could be used to determine the trucking cost share of the total delivered price of a product or sector. Using the change in trucking prices described in the aggregate approach, the product-specific demand elasticities could be used to calculate the change in sales and shipments for each product. The change in shipment increases could then be weighted by the share of the trucking industry total, and then summed to get the total increase in trucking output. A simplifying assumption could then be made that the increase in output results in an increase in VMT. This type of detailed data has not yet been collected, so we do not have any calculations available for the proposal. While we hope to have this data available for the final rulemaking, gathering high quality data may take a longer time frame. We invite the submission of comments or data that could be used as part of this methodology.

(iii) Eonometric Estimates

Similar to the methodology used to estimate the light-duty rebound effect, the heavy-duty rebound effect could be modeled econometrically by estimating truck demand as a function of economic activity (*e.g.,* GDP) and different input prices (*e.g.,* vehicle prices, driver wages, and fuel costs per mile). This type of econometric model could be estimated for either truck VMT or ton-miles as a measure of demand. The resulting elasticity estimates could then be used to determine the change in trucking demand, given the change in fuel cost and truck prices per mile from these standards.

(iv) Other Modeling Approaches

Regulation of the heavy-duty industry has been studied in more detail in Europe, as the European Commission (EC) has considered allowing longer and heavier trucks for freight transport. Part of the analysis considered by the EC relies on country-specific modeling of changes in the freight sector that would result from changes in regulations.[391] This approach attempts to explicitly calculate modal shift decisions and impacts on GHG emissions. Although similar types of analysis have not been conducted extensively in the United States, research is currently underway that explores the potential for intermodal shifting in the United States. For example, Winebrake and Corbett have developed the Geospatial Intermodal Freight Transportation model, which evaluates the potential for GHG emissions reductions based on mode shifting, given existing limitations of infrastructure and other route characteristics in the United States.[392] This model connects multiple road, rail, and waterway transportation networks and embeds activity-based calculations in the model. Within this intermodal network, the model assigns various economic, time-of-delivery, energy, and environmental attributes to real-world goods movement routes. The model can then calculate different network optimization scenarios, based on changes in prices and policies.[393] However, more work is needed in this area to determine whether this type of methodology is appropriate for the purposes of capturing the rebound effect. We invite comment on this approach, as well as suggestions on alternative modeling frameworks that could be used to assess mode shifting, fuel consumption, and the GHG

[387] Winston, C. (1981). The welfare effects of ICC rate regulation revisited. The Bell Journal of Economics, 12, 232–244 (Docket ID: EPA–HQ–OAR–2010–0162–0021).

[388] *See* 2010 NAS Report, Note 111. *See also* 2009 Cambridge Systematics, Inc., Draft Final Paper commissioned by the NAS in support of the medium-duty and heavy-duty report. Assessment of Fuel Economy Technologies for Medium and Heavy-duty Vehicles: Commissioned Paper on Indirect Costs and Alternative Approaches Docket ID: EPA–HQ–OAR–2010–0162–0009).

[389] Friedlaender, A. and Spady, R. (1980) A derived demand function for freight transportation, Review of Economics and Statistics, 62, pp. 432–441 (Docket ID: EPA–HQ–OAR–2010–0162–0004).

[390] Christidis and Leduc, "Longer and Heavier Vehicles for freight transport," European Commission Joint Research Center's Institute for Prospective Technology Studies, 2009 (Docket ID: EPA–HQ–OAR–2010–0162–0010).

[391] Christidis and Leduc, "Longer and Heavier Vehicles for freight transport," European Commission Joint Research Center's Institute for Prospective Technology Studies, 2009.

[392] Winebrake, James and James J. Corbet (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* (Docket ID: EPA–HQ–OAR–2010–0162–0011)

[393] 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).

emission implications of these proposed regulations.

(c) Estimates of the Rebound Effect

The aggregate methodology was used by Cambridge Systematics, Inc. (CSI) to show several examples of the magnitude of the rebound effect. [394] In their paper commissioned by the NAS in support of the recent medium- and heavy-duty report, CSI calculated an effective rebound effect for two different technology cost and fuel savings scenarios associated with an example Class 8 truck. Scenario 1 increased average fuel economy from 5.59 mpg to 6.8 mpg, with an additional cost of $22,930. Scenario 2 increased the average fuel economy to 9.1 mpg, at an incremental cost of $71,630 per vehicle. The CSI examples provided estimates using a range of own-price elasticities (−0.5 to −1.5) and cross-price elasticities (0.35 to 0.59) from the literature. Based on these two scenarios and a number of simplifying assumptions to aid the calculations, CSI found a rebound effect of 11–31% for Scenario 1 and 5–16% for Scenario 2 when the fuel savings from rail were not taken into account ("First rebound effect"). When the fuel savings from reduced rail usage were included in the calculations, the overall rebound effect was between 9–13% for Scenario 1 and 3–15% for Scenario 2 ("Second Rebound Effect"). *See* Table VIII–12.

CSI included a number of caveats associated with these calculations. Namely, the 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), analysis geography, trip lengths, markets served, and commodities transported." Furthermore, the CSI example only focused on Class 8 combination tractors and did not attempt to quantify the potential rebound effect for any other truck classes. Finally, these scenarios were characterized as "sketches" and were not included in the final NAS report. In fact, the NAS report asserted that it is "not possible to provide a confident measure of the rebound effect," yet concluded that a rebound effect likely exists and that "estimates of fuel savings from regulatory standards will be somewhat misestimated if the rebound effect is not considered."

Table VIII-12: Range of Rebound Effect Estimates from Cambridge Systematics Aggregate Assessment

	Scenario 1 (6.8 mpg, $22,930)	Scenario 2 (9.1 mpg, $71,630)
"First Rebound Effect" (increase in truck VMT resulting from decrease in operating costs)	11-31%	5-16%
"Second Rebound Effect" (net fuel savings when decreases from rail are taken into account)	9-13 %	3-15%

As an alternative, using the econometric approach, NHTSA has estimated the rebound effect in the short run and long run for single unit (Class 4–7) and (Class 8) combination tractors. As shown in Table VIII–13, the estimates for the long-run rebound effect are larger than the estimates in the short run, which is consistent with the theory that shippers have more flexibility to change their behavior (*e.g.*, restructure contracts or logistics) when they are given more time. In addition, the estimates derived from the national data also showed larger rebound effects compared to the State data.[395] One possible explanation for the difference in the estimates is that the national rebound estimates are capturing some of the impacts of changes in economic activity. Historically, large increases in fuel prices are highly correlated with economic downturns, and there may not be enough variation in the national data to differentiate the impact of fuel price changes from changes in economic activity. In contrast, some States may see an increase in output when energy prices increase (*e.g.*, large oil producing States such as Texas and Alaska); therefore, the State data may be more accurately isolating the individual impact of fuel price changes.

Table VIII-13: Range of Rebound Effect Estimates from NHTSA Econometric Analysis

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%

[394] Cambridge Systematics, Inc., 2009.

[395] NHTSA's estimates of the rebound effect are derived from econometric analysis of national and state VMT data reported in Federal Highway Administration, *Highway Statistics*, various editions, Tables VM–1 and VM–4. Specifically, the estimates of the rebound effect reported in Table VIII–10 are ranges of the estimated short-run and long-run elasticities of annual VMT by single-unit and combination trucks with respect to fuel cost per mile driven. (Fuel cost per mile driven during each year is equal to average fuel price per gallon during that year divided by average fuel economy of the truck fleet during that same year.) These estimates are derived from time-series regression of annual national aggregate VMT for the period 1970–2008 on measures of nationwide economic activity, including aggregate GDP, the value of durable and nondurable goods production, and the volume of U.S. exports and imports of goods, and variables affecting the price of trucking services (driver wage rates, truck purchase prices, and fuel costs), and from regression of VMT for each individual State over the period 1994–2008 on similar variables measured at the State level.

As discussed throughout this section, there are multiple methodologies for quantifying the rebound effect, and these different methodologies produce a large range of potential values of the rebound effect. However, for the purposes of quantifying the rebound effect for this proposal, we have used a rebound effect with respect to changes in fuel costs per mile on the lower range of the long-run estimates. Given the fact that the long-run State estimates are generally more consistent with the aggregate estimates, for this proposal we have chosen a rebound effect for vocational vehicles (single unit trucks) of 15% that is within the range of estimates from both methodologies. Similarly, we have chosen a rebound effect for combination tractors of 5%.

To date, no estimates of the HD pickup truck and van rebound effect have been cited in the literature. Since these vehicles are used for very different purposes than heavy-duty vehicles, it does not necessarily seem appropriate to apply one of the heavy-duty estimates to the HD pickup trucks and vans. These vehicles are more similar in use to large light-duty vehicles, so for the purposes of our analysis, we have chosen to apply the light-duty rebound effect of 10% to this class of vehicles.

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 shifting. However, we have provided CSI's example calculations and request comment on these values.

Furthermore, we have made a number of simplifying assumptions in our calculations, which are discussed in more detail in the draft RIA. Specifically, we have not attempted to capture how current market failures might impact the rebound effect. The direction and magnitude of the rebound effect in the medium- and heavy-duty truck market are expected to vary depending on the existence and types of market failures affecting the fuel economy of the trucking fleet. If firms are already accurately accounting for the costs and benefits of these technologies and fuel savings, then these regulations would increase their net costs, because trucks would already include all the cost-effective technologies. As a result, the rebound effect would actually be negative and truck VMT would decrease as a result of these proposed regulations. However, if firms are not optimizing their behavior today due to factors such as lack of reliable information (*see* Section VIII.A. for further discussion), it is more likely that truck VMT would increase. If firms recognize their lower net costs as a result of these regulations and pass those costs along to their customers, then the rebound effect would increase truck VMT. This response assumes that trucking rates include both truck purchase costs and fuel costs, and that the truck purchase costs included in the rates spread those costs over the full expected lifetime of the trucks. If those costs are spread over a shorter period, as the expected short payback period implies, then those purchase costs will inhibit reduction of freight rates, and the rebound effect will be smaller.

As discussed in more detail in Section VIII.A, if there are market failures such as split incentives, estimating the rebound effect may depend on the nature of the failures. For example, if the original purchaser cannot fully recoup the higher upfront costs through fuel savings before selling the vehicle nor pass those costs onto the resale buyer, the firm would be expected to raise shipping rates. A firm purchasing the truck second-hand might lower shipping rates if the firm recognizes the cost savings after operating the vehicle, leading to an increase in VMT. Similarly, if there are split incentives and the vehicle buyer isn't the same entity that purchases the fuel, than there would theoretically be a positive rebound effect. In this scenario, fuel savings would lower the net costs to the fuel purchaser, which would result in a larger increase in truck VMT.

If all of these scenarios occur in the marketplace, the net effect will depend on the extent and magnitude of their relative effects, which are also likely to vary across truck classes (for instance, split incentives may be a much larger problem for Class 7 and 8 tractors than they are for heavy-duty pickup trucks). Additional details on the rebound effect are included in the draft RIA. We invite comment on all of the rebound estimates and assumptions.

F. Class Shifting and Fleet Turnover Impacts

The agencies considered two additional potential indirect costs, benefits, effects, and externalities which may lead to unintended consequences of the proposal 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 agencies propose a regulation that impacts either the performance of the vehicle or the marginal cost of the vehicle relative to the other vehicle classes, then consumers could choose to purchase a different vehicle which may result in an 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.[396] The agencies welcome comments that would help inform the evaluation of this potential impact. NHTSA and EPA qualitatively evaluated the proposed rule 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, from combination tractors to vocational vehicles, and within vocational vehicles.

Light-duty pickup trucks, those with a GVWR of less than 8,500 pounds, are currently regulated under the existing CAFE program and will meet GHG emissions standards beginning in 2012. The increased stringency of the 2012–2016 light-duty GHG and CAFE rule has led some to speculate that vehicle consumers may choose to purchase heavy-duty pickup trucks that are currently unregulated 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 proposal. With this proposed regulation, any incentive for such a class shift is significantly diminished. 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

[396] *See* 2010 NAS Report, Note 111, page 152.

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 are significantly more efficient than heavy-duty pickup trucks.

The projected cost increases for our proposal differ significantly between Class 8 day cabs and Class 8 sleeper cabs reflecting our expectation that compliance with the proposed standards will lead truck consumers to specify sleeper cabs equipped with APUs while day cab consumers will 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 will 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.[397] A day cab simply cannot provide this utility. The need for this utility would not be changed even if the marginal costs to reduce greenhouse gas emissions from sleeper cabs exceed the marginal costs to reduce greenhouse gas emissions from day cabs.[398] A trucking fleet could 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 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 providing 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 will automatically eliminate any additional idling through the shutdown software. If trucking companies choose this option, then costs based on purchase of APUs may overestimate the costs of this rule 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 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 will cause class shifting within the vocational 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 will outweigh the additional cost for heavier vehicles.[399]

In conclusion, NHTSA and EPA believe that the proposed regulatory structure for HD trucks does not significantly change the current competitive and market factors that determine purchaser preferences among truck types. Furthermore, even if a small amount of shifting does occur, any resulting GHG impacts are likely to be negligible because any vehicle class that sees an uptick in sales is also being regulated for fuel economy. Therefore, the agencies did not include an impact of class shifting on the vehicle populations used to assess the benefits of the proposal. The agencies welcome comments to inform the benefits assessment of the final rule.

(2) Fleet Turnover Effect

A regulation that increases the cost to purchase and/or operate trucks could impact 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 NAS panel discusses 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.[400] 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

[397] 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–2010–0162–0044.

[398] The average marginal cost difference between sleeper cabs and day cabs in the proposal is nearly $6,000.

[399] The proposed rule projects the difference in costs between the HHD and MHD vocational vehicle technologies is approximately $30.

[400] *See* NAS Report, Note 111, pp. 150–151.

efficiency investments, most heavy-duty fleet operators require relatively quick payback periods, on the order of two to three years.[401]

The proposed regulations are projected to return fuel savings to the truck owners that offset the cost of the regulation within a few years for vocational vehicles and Class 7 and 8 tractors, the categories where the potential for prebuy and delayed fleet turnover are concerns. In the case of vocational vehicles, the added cost is small enough that it is unlikely to have a substantial effect on purchasing behavior. In the case of Class 7 and 8 trucks, the effects of the regulation on purchasing behavior 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 VIII.A., this scenario may occur if this proposed rule 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.

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 economy 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 VIII.A) between truck purchasers (who 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. We welcome comments on all aspects of this assumption, especially in the context of our assumed increase in truck freight shipments due to a VMT rebound.

G. Benefits of Reducing CO_2 Emissions

(1) Social Cost of Carbon

EPA has assigned a dollar value to reductions in CO_2 emissions using recent estimates of the social cost of carbon (SCC). The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change. The SCC estimates used in this analysis were developed through an interagency process that included EPA, DOT/NHTSA, and other executive branch entities, and concluded in February 2010. We first used these SCC estimates in the benefits analysis for the final joint EPA/DOT rule to establish light-duty vehicle GHG emission standards and CAFE standards; see the rule's preamble for discussion about application of the SCC.[402] The SCC Technical Support Document (SCC TSD) provides a complete discussion of the methods used to develop these SCC estimates.[403]

The interagency group selected four SCC values for use in regulatory analyses, which we have applied in this analysis: $5, $22, $36, and $66 per metric ton of CO_2 emissions in 2010, in 2008 dollars.[404, 405] The first three values are based on the average SCC from three integrated assessment models, at discount rates of 5, 3, and 2.5 percent, respectively. SCCs at several discount rates are included because the literature shows that the SCC is quite sensitive to assumptions about the discount rate, and because no consensus exists on the appropriate rate to use in an intergenerational context. The fourth value is the 95th percentile of the SCC 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 SCC distribution. Low probability, high impact events are incorporated into all of the SCC values through explicit consideration of their effects in two of the three models as well as the use of a probability density function for equilibrium climate sensitivity. Treating climate sensitivity probabilistically results in more high temperature outcomes, which in turn lead to higher projections of damages.

The SCC increases over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change. Note that the interagency group estimated the growth rate of the SCC directly using the three integrated assessment models rather than assuming a constant annual growth rate. This helps to ensure that the estimates are internally consistent with other modeling assumptions. Table VIII–14 presents the SCC estimates used in this analysis.

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of serious challenges. A recent report from the National Academies of Science points out that any assessment will suffer from uncertainty, speculation, and lack of information about (1) future emissions of greenhouse gases, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages.[406] As a result, any effort to quantify and monetize the harms

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[401] *See* NAS Report, Note 111, page 151.

[402] See U.S. EPA 2010 LD GHG Rule, Note 6, docket ID EPA–HQ–OAR–2009–0472–11424.

[403] 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 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 (February 2010). Also available at *http://epa.gov/otaq/climate/regulations.htm.*

[404] The interagency group decided that these estimates apply only to CO_2 emissions. Given that warming profiles and impacts other than temperature change (*e.g.,* ocean acidification) vary across GHGs, the group concluded "transforming gases into CO_2-equivalents using GWP, and then multiplying the carbon-equivalents by the SCC, would not result in accurate estimates of the social costs of non-CO_2 gases" (SCC TSD, pg. 13).

[405] The SCC estimates were converted from 2007 dollars to 2008 dollars using a GDP price deflator (1.021) obtained from the Bureau of Economic Analysis, National Income and Product Accounts Table 1.1.4, *Prices Indexes for Gross Domestic Product.*

[406] *National Research Council (2009). Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* National Academies Press. See docket ID EPA–HQ–OAR–2009–0472–11486.

associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

The interagency group noted a number of limitations to the SCC analysis, including the incomplete way in which the integrated assessment models 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. The limited amount of research linking climate impacts to economic damages makes the interagency modeling exercise even more difficult. The interagency group hopes that over time researchers and modelers will work to fill these gaps and that the SCC estimates used for regulatory analysis by the Federal government will continue to evolve with improvements in modeling. Additional details on these limitations are discussed in the SCC TSD.

In light of these limitations, the interagency group has committed to updating the current estimates as the science and economic understanding of climate change and its impacts on society improves over time. Specifically, the interagency group has set a preliminary goal of revisiting the SCC values in the next few years or at such time as substantially updated models become available, and to continue to support research in this area.

Applying the global SCC estimates, shown in Table VIII–14, to the estimated domestic reductions in CO_2 emissions under this proposed rule, we estimate the dollar value of the climate related benefits for each analysis year. For internal consistency, the annual benefits are discounted back to net present value terms using the same discount rate as each SCC estimate (*i.e.,* 5%, 3%, and 2.5%) rather than 3% and 7%.[407] These estimates are provided in Table VIII–15.

Table VIII-14: Social Cost of CO_2, 2010 – 2050[a] (in 2008 dollars)

Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	3% 95th Percentile
2010	$4.80	$21.85	$35.84	$66.26
2015	$5.87	$24.35	$39.21	$74.33
2020	$6.94	$26.85	$42.58	$82.39
2025	$8.45	$30.15	$46.84	$92.25
2030	$9.95	$33.44	$51.10	$102.10
2035	$11.46	$36.73	$55.36	$111.95
2040	$12.97	$40.02	$59.63	$121.81
2045	$14.50	$42.93	$63.00	$130.43
2050	$16.03	$45.84	$66.37	$139.06

Note:
[a] The SCC values are dollar-year and emissions-year specific.

Table VIII-15: Monetized CO_2 Benefits of Vehicle Program, CO_2 Emissions[a] (Million 2008$)

YEAR	CO_2 EMISSIONS REDUCTION (MMT)	BENEFITS			
		Avg SCC at 5% ($5-$16)[a]	Avg SCC at 3% ($22-$46)[a]	Avg SCC at 2.5% ($36-$66)[a]	95th percentile SCC at 3% ($66-$139)[a]
2020	34.1	$237	$916	$1,452	$2,810
2030	69.2	$689	$2,313	$3,535	$7,063
2040	88.9	$1,153	$3,559	$5,302	$10,832
2050	107	$1,709	$4,888	$7,076	$14,826
Net Present Value[b]		$8,610	$44,000	$74,600	$134,000

Notes:
[a] Except for the last row (net present value), the SCC values are dollar-year and emissions-year specific.
[b] Net present value of reduced CO_2 emissions is calculated differently from other benefits. The same discount rate used to discount the value of damages from future emissions (SCC 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.

[407] It is possible that other benefits or costs of proposed regulations unrelated to CO_2 emissions will be discounted at rates that differ from those used to develop the SCC estimates.

H. Non-GHG Health and Environmental Impacts

This section discusses the non-GHG health and environmental impacts that can be expected to occur as a result of the proposed heavy-duty vehicle GHG rule. GHG emissions are predominantly the byproduct of fossil fuel combustion processes that also produce criteria and hazardous air pollutants. The vehicles that are subject to the proposed standards are also significant sources of mobile source air pollution such as direct PM, NO_X X, VOCs and air toxics. The proposed standards would affect exhaust emissions of these pollutants from vehicles. They would also affect emissions from upstream sources related to changes in fuel consumption. Changes in ambient ozone, $PM_{2.5}$, and air toxics that would result from the proposed standards are expected to affect human health in the form of premature deaths and other serious human health effects, as well as other important public health and welfare effects.

It is important to quantify the health and environmental impacts associated with the proposed standard because a failure to adequately consider these ancillary co-pollutant impacts could lead to an incorrect assessment of their net costs and benefits. Moreover, co-pollutant impacts tend to accrue in the near term, while any effects from reduced climate change mostly accrue over a time frame of several decades or longer.

EPA typically quantifies and monetizes the health and environmental impacts related to both PM and ozone in its regulatory impact analyses (RIAs), when possible. However, EPA was unable to do so in time for this proposal. EPA attempts to make emissions and air quality modeling decisions early in the analytical process so that we can complete the photochemical air quality modeling and use that data to inform the health and environmental impacts analysis. Resource and time constraints precluded the Agency from completing this work in time for the proposal. Instead, we provide a characterization of the health and environmental impacts that will be quantified and monetized for the final rulemaking.

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 Ozone NAAQS and the final PM NAAQS analysis, as well as the proposed Portland Cement National Emissions Standards for Hazardous Air Pollutants RIA, and final NO_2 NAAQS.[408, 409, 410, 411]

Though EPA is characterizing the changes in emissions associated with toxic pollutants, we will not be able to quantify or monetize the human health effects associated with air toxic pollutants for either the proposal or the final rule analyses. Please refer to Section VII for more information about the air toxics emissions impacts associated with the proposed standards.

(1) 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* VII.C 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 (BenMAP).[412] BenMAP 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 8.3 in the draft RIA that accompanies this proposal lists the co-pollutant health effect exposure-response functions EPA will use to quantify the co-pollutant incidence impacts associated with the final heavy-duty vehicles standard. These include PM- and ozone-related premature mortality, chronic bronchitis, nonfatal heart attacks, hospital admissions (respiratory and cardiovascular), emergency room visits, acute bronchitis, minor restricted activity days, and days of work and school lost.

(2) 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 derived from the mortality valuation literature. For certain health impacts, such as chronic bronchitis and 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 8.3 in the draft RIA that accompanies this proposal presents the monetary values EPA will apply to changes in the incidence of health and welfare effects associated with the final standard.

(3) 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, and acrolein), ambient ozone, and ambient $PM_{2.5}$ exposures. Chapter 8.3 of the draft RIA 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. The EPA Science Advisory Board specifically commented in their review of the 1996 National-scale Air Toxics Assessments 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

[408] U.S. Environmental Protection Agency. (2008). Final Ozone NAAQS Regulatory Impact Analysis. Prepared by: Office of Air and Radiation, Office of Air Quality Planning and Standards. March.

[409] U.S. Environmental Protection Agency. October 2006. Final Regulatory Impact Analysis (RIA) for the Proposed National Ambient Air Quality Standards for Particulate Matter. Prepared by: Office of Air and Radiation.

[410] U.S. Environmental Protection Agency (U.S. EPA). 2009. Regulatory Impact Analysis: National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry. Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. Available on the Internet at *http://www.epa.gov/ttn/ecas/regdata/RIAs/portlandcementria_4–20–09.pdf.* EPA–HQ–OAR–2009–0472–0241.

[411] U.S. Environmental Protection Agency (U.S. EPA). 2010. Final NO_2 NAAQS Regulatory Impact Analysis (RIA). Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. Available on the Internet at *http://www.epa.gov/ttn/ecas/regdata/RIAs/FinalNO2RIAfulldocument.pdf.* Accessed March 15. EPA–HQ–OAR–2009–0472–0237.

[412] Information on BenMAP, including downloads of the software, can be found at *http://www.epa.gov/ttn/ecas/benmodels.html.*

address sub-chronic health effects.[413] While EPA has since improved the tools, there remain critical limitations for estimating incidence and assessing benefits of reducing mobile source air toxics. 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.[414]

I. Energy Security Impacts

This proposed rule to reduce fuel consumption and GHG emissions in heavy-duty vehicles results in improved fuel efficiency which, in turn, helps 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 United States. This reduction in risk is a measure of improved U.S. energy security. This section summarizes our estimates of U.S. oil import reductions and energy security benefits of the proposed heavy-duty fuel consumption and GHG vehicle standards. Additional discussion of this issue can be found in Chapter 9.5 of the draft RIA.

(1) Implications of Reduced Petroleum Use on U.S. Imports

In 2008, U.S. petroleum import expenditures represented 21 percent of total U.S. imports of all goods and services.[415] In 2008, the United States imported 66 percent of the petroleum it consumed, and the transportation sector accounted for 70 percent of total U.S. petroleum consumption. This compares to approximately 37 percent of petroleum from imports and 55 percent of consumption from petroleum in the transportation sector in 1975.[416] It is clear that petroleum imports have a significant impact on the U.S. economy.

Requiring lower-GHG vehicle technology in heavy-duty vehicles in the United States is expected to lower U.S. oil imports. EPA used the MOVES model to estimate the fuel savings due to this proposal. A detailed explanation of the MOVES model can be found in Chapter 5 of the draft RIA.

Based on a detailed analysis of differences in fuel consumption, petroleum imports, and imports of refined petroleum products and crude oil among the Reference Case, High Economic Growth, and Low Economic Growth Scenarios presented in the Energy Information Administration's Annual Energy Outlook (AEO) 2009, EPA and NHTSA estimate that approximately 50 percent of the reduction in fuel consumption resulting from adopting improved fuel GHG standards and fuel economy standards is likely to be reflected in reduced U.S. imports of refined fuel, while the remaining 50 percent would be expected to be reflected in reduced domestic fuel refining. Of this latter figure, 90 percent is anticipated to reduce U.S. imports of crude petroleum for use as a refinery feedstock, while the remaining 10 percent is expected to reduce U.S. domestic production of crude petroleum. Thus, on balance, each gallon of fuel saved as a consequence of the heavy-duty GHG standards and fuel economy standards is anticipated to reduce total U.S. imports of crude petroleum or refined fuel by 0.95 gallons.[417] EPA estimates of the reduction in U.S. oil imports from this proposal for the years 2020, 2030 and 2040, in millions of barrels per day, are presented in Table VIII–16 below.

Table VIII-16: U.S. Oil Import Reductions from the Heavy-Duty Vehicle Rule in 2020, 2030 and 2040 (in millions of barrels per day)

2020	2030	2040
0.177	0.357	0.463

(2) Energy Security Implications

In order to understand the energy security implications of reducing U.S. petroleum imports, EPA worked with Oak Ridge National Laboratory (ORNL), which has developed approaches for evaluating the economic 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 study is included as part of the docket for this proposal.[418, 419]

When conducting this analysis, ORNL considered the full economic cost of importing petroleum into the United States. The economic cost of importing petroleum into the United States 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 increasing U.S. import demand on the world oil price and on the market power of the Organization of the Petroleum Exporting Countries (*i.e.*, the "demand" or "monopsony" costs); and (2) the risk of reductions in U.S. economic output and disruption of the U.S. economy caused by sudden disruptions in the supply of imported petroleum to the United States (*i.e.*, macroeconomic disruption/adjustment costs). Maintaining a U.S. military presence to help secure stable oil supply from potentially vulnerable regions of the world was not included in this analysis because its attribution to particular missions or activities is hard to quantify.

[413] 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*.

[414] 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 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.

[415] Source: U.S. Bureau of Economic Analysis, U.S. International Transactions Accounts Data, as shown on June 24, 2009.

[416] Source: U.S. Department of Energy, Annual Energy Review 2008, Report No. DOE/EIA–0384 (2008), Tables 5.1 and 5.13c, June 26, 2009.

[417] This figure is calculated as $0.50 + 0.50*0.9 = 0.50 + 0.45 = 0.95$.

[418] Leiby, Paul N., "*Estimating the Energy Security Benefits of Reduced U.S. Oil Imports*" Oak Ridge National Laboratory, ORNL/TM–2007/028, Final Report, 2008. (Docket EPA–HQ–OAR–2010–0162).

[419] The ORNL study "*The Energy Security Benefits of Reduced Oil Use, 2006–2015*," completed in March 2008, is an update version of the approach used for estimating the energy security benefits of U.S. oil import reductions developed in an ORNL 1997 Report by Leiby, Paul N., Donald W. Jones, T. Randall Curlee, and Russell Lee, entitled "*Oil Imports: An Assessment of Benefits and Costs*." (Docket EPA–HQ–OAR–2010–0162).

As part of the process for developing the ORNL energy security estimates, EPA sponsored an independent, expert peer review of the 2008 ORNL study. A report compiling the peer reviewers' comments is provided in the docket.[420] In addition, EPA has worked with ORNL to address comments raised in the peer review and to develop estimates of the energy security benefits associated with a reduction in U.S. oil imports for this heavy-duty vehicle rule. In response to peer reviewer comments, ORNL modified its model by changing several key parameters involving the coordinated supply behavior of petroleum-exporting countries, the responsiveness of oil demand and supply to a change in the world oil price, and the responsiveness of U.S. economic output to a change in the world oil price.

For this proposed rule, ORNL estimated energy security premiums by incorporating the most recent available AEO 2010 oil price forecasts and market trends. Energy security premiums for the years 2020, 2030 and 2040 are presented in Table VIII–17,[421] as well as a breakdown of the components of the energy security premiums for each of these years. The components of the energy security premiums and their values are discussed in detail in Chapter 9.4 of the RIA.

Table VIII-17: Energy Security Premiums in 2020, 2030 and 2040 (2008$/Barrel)

Year (range)	Monopsony	Macroeconomic Disruption/Adjustment Costs	Total Mid-Point
2020	$12.28 ($4.16 - $23.74)	$7.39 ($3.39 – $11.92)	$19.66 ($10.27 - $30.90)
2030	$12.69 ($4.43 – 23.80)	$8.54 ($4.10 – $13.60)	$21.23 ($11.30 - $32.88)
2040	$12.68 ($4.41 – $23.41)	$8.99 ($4.48 - $14.08)	$21.67 ($11.54 - $33.11)

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 SCC value, the question arises: how should the energy security premium be determined when a global perspective is taken? Monopsony benefits represent avoided payments by the United States to oil producers in foreign countries that result from a decrease in the world oil price as the United States decreases its consumption of imported oil.

Although there is clearly a benefit to the United States when considered from a domestic perspective, the decrease in price due to decreased demand in the United States also represents a loss to other countries. Given the redistributive nature of this monopsony effect from a global perspective, it is excluded in the energy security benefits calculations for this proposal. In contrast, the other portion of the energy security premium, the U.S. macroeconomic disruption and adjustment costs that arise from U.S. petroleum imports, does not have offsetting impacts outside of the United States, and, thus, are included in the energy security benefits estimated for this proposal. To summarize, the agencies have included only the macroeconomic disruption portion of the energy security benefits to monetize the total energy security benefits of this proposal.

The total annual energy security benefits for the proposed heavy-duty vehicle rule are reported in Table VIII–18 for the years 2020, 2030 and 2040. These estimates include only the macroeconomic disruption/adjustment portion of the energy security premium.

Table VIII-18: Total Annual Energy Security Benefits from the Heavy-Duty Vehicle Rule in 2020, 2030 and 2040 (millions of 2008$)

Year	Benefits
2020	$479
2030	$1,117
2040	$1,526

J. Other Impacts

(1) Noise, Congestion and Accidents

Increased vehicle use associated with a positive rebound effect also contributes to increased traffic congestion, motor vehicle accidents, and highway noise. Depending on how the additional travel is distributed throughout the day and on where it takes place, additional vehicle use can contribute to traffic congestion and delays by increasing traffic volumes on facilities that are already heavily traveled during peak periods. These added delays impose higher costs on drivers and other vehicle occupants in the form of increased travel time and operating expenses, increased costs associated with traffic accidents, and increased traffic noise. Because drivers

420 Peer Review Report Summary: Estimating the Energy Security Benefits of Reduced U.S. Oil Imports, ICF, Inc., September 2007.

421 AEO 2009 forecasts energy market trends and values only to 2035. The energy security premium estimates post-2035 were assumed to be the 2035 estimate.

do not take these added costs into account in deciding when and where to travel, they must be accounted for separately as a cost of the added driving associated with the rebound effect.

EPA and NHTSA rely on estimates of congestion, accident, and noise costs caused by pickup trucks and vans, single unit trucks, buses, and combination tractors developed by the Federal Highway Administration to estimate the increased external costs caused by added driving due to the rebound effect.[422] The Federal Highway Administration (FHWA) estimates are intended to measure the increases in costs from added congestion, property damages and injuries in traffic accidents, and noise levels caused by various types of trucks that are borne by persons other than their drivers (or "marginal" external costs). EPA and NHTSA employed estimates from this source previously in the analysis accompanying the Light-Duty GHG final rule. The agencies continue to find them appropriate for this analysis after reviewing the procedures used by FHWA to develop them and considering other available estimates of these values.

FHWA's congestion cost estimates for trucks, which are weighted averages based on the estimated fractions of peak and off-peak freeway travel for each class of trucks, already account for the fact that trucks make up a smaller fraction of peak period traffic on congested roads because they try to avoid peak periods when possible. FHWA's congestion cost estimates focus on freeways because non-freeway effects are less serious due to lower traffic volumes and opportunities to re-route around the congestion. The agencies, however, applied the congestion cost to the overall VMT increase, though the fraction of VMT on each road type used in MOVES range from 27 to 29 percent of the vehicle miles on freeways for vocational vehicles and 53 percent for combination tractors. The results of this analysis potentially overestimate the costs and provide a conservative estimate. The agencies welcome comments on whether the cost calculations should be done differently in the final rulemaking.

The agencies are proposing to use FHWA's "Middle" estimates for marginal congestion, accident, and noise costs caused by increased travel from trucks. This approach is consistent with the current methodology used in the Light-Duty GHG rulemaking analysis. These costs are multiplied by the annual increases in vehicle miles travelled from the positive rebound effect to yield the estimated cost increases resulting from increased congestion, accidents, and noise during each future year. The values the agencies used to calculate these increased costs are included in Table VIII–19.

Table VIII-19 Noise, Accident, and Congestion Costs per Mile (2008$)

External Costs	Pickup truck and vans ($/VMT)	Vocational vehicles ($/VMT)	Combination tractors ($/VMT)
Congestion	$0.049	$0.110	$0.107
Accidents	$0.026	$0.019	$0.022
Noise	$0.001	$0.009	$0.020

In aggregate, the increased costs due to noise, accidents, and congestion from the additional truck driving are presented in Table VIII–20.

Table VIII-20 Accident, Noise, and Congestion Costs (Millions, 2008$)

Year	Class 2b&3	Vocational	Combination	Total Costs
2012	$0	$0	$0	$0
2013	$0	$0	$0	$0
2014	$8	$10	$18	$36
2015	$16	$19	$35	$70
2016	$23	$30	$52	$104
2017	$30	$39	$68	$137
2018	$37	$48	$83	$168
2020	$50	$64	$111	$225
2030	$89	$122	$193	$404
2040	$112	$182	$233	$527
2050	$133	$245	$271	$648
NPV, 3%	$1,606	$2,407	$3,439	$7,452
NPV, 7%	$746	$1,070	$1,614	$3,429

[422] These estimates were developed by FHWA for use in its 1997 *Federal Highway Cost Allocation Study; see http://www.fhwa.dot.gov/policy/hcas/final/index.htm* (last accessed July 21, 2010).

(2) Savings Due to Reduced Refueling Time

Reducing the fuel consumption of heavy-duty trucks may either increase their driving range before they require refueling, or motivate truck purchasers to buy, and manufacturers to offer, smaller fuel tanks. Keeping the fuel tank the same size allows truck operators to reduce the frequency with which drivers typically refuel their vehicles; it thus extends the upper limit of the range they can travel before requiring refueling. Alternatively, if purchasers and manufacturers respond to improved fuel economy by reducing the size of fuel tanks to maintain a constant driving range, the smaller tank will require less time in actual refueling.

Because refueling time represents a time cost of truck operation, these time savings should be incorporated into truck purchasers' decisions over how much fuel-saving technology they want in their vehicles. The savings calculated here thus raise the same questions discussed in Preamble VIII.A and draft RIA Section 9.1: Does the apparent existence of these savings reflect failures in the market for fuel economy, or does it reflect costs not addressed in this analysis? The response to these questions could vary across truck segment. See those sections for further analysis of this question.

This analysis estimates the reduction in the annual time spent filling the fuel tank; this reduced time could come either from fewer refueling events, if the fuel tank stays the same size, or less time spent during each refueling event, if the fuel tank is made proportionately smaller. The refueling savings are calculated as the savings in the amount of time that would have been necessary to pump the fuel. The calculation does not include time spent searching for a fuel station or other time spent at the station; it is assumed that the time savings occur only during refueling. The value of the time saved is estimated at the hourly rate recommended for truck operators ($22.15 in 2008 dollars) in DOT guidance for valuing time savings.[423]

The refueling savings include the increased fuel consumption resulting from additional mileage associated with the rebound effect. However, the estimate of the rebound effect does not account for any reduction in net operating costs from lower refueling time. As discussed earlier, the rebound effect should be a measure of the change in VMT with respect to the net change in overall operating costs. Ideally, changes in refueling time would factor into this calculation, although the effect is expected to be minor because refueling time savings are small relative to the value of reduced fuel expenditures.

The details of this calculation are discussed in the draft RIA Chapter 9.3.2. The savings associated with reduced refueling time for a truck of each type throughout its lifetime are shown in Table VIII–21. The aggregate savings associated with reduced refueling time are shown in Table VIII–22 for vehicles sold in 2014 through 2050. EPA and NHTSA request comment on whether reduced refueling time will result from greater fuel efficiency and how it may vary by truck segment.

[423] U.S. Department of Transportation, "Revised Departmental Guidance for Valuation of Travel Time in Economic Analysis," February 11, 2003, Table 4 (which shows a value of $18.10 in 2000 dollars); available at *http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2-11-03.pdf* (last accessed September 9, 2010).

Table VIII-21: Lifetime Refueling Savings for a 2018 MY Truck of Each Type (2008$)

	Pickup Trucks and Vans	Vocational Vehicles	Combination Tractor
3% Discount Rate	$64	$220	$294
7% Discount Rate	$50	$176	$235

Table VIII-22 Annual Refueling Savings (Millions of 2008 dollars)

Year	Pickup Trucks and Vans	Vocational Vehicles	Combination Tractor	Total
2012	$0	$0	$0	$0
2013	$0	$0	$0	$0
2014	$0	$1.8	$4.9	$6.9
2015	$0.6	$3.4	$10	$14
2016	$1.6	$5.2	$14	$21
2017	$3.2	$8.6	$21	$32
2018	$6.1	$12	$27	$45
2020	$12	$17	$38	$67
2030	$31	$38	$73	$141
2040	$42	$58	$89	$188
2050	$51	$78	$103	$231
NPV, 3%	$532	$730	$1,267	$2,529
NPV, 7%	$229	$316	$584	$1,129

(3) The Effect of Safety Standards and Voluntary Safety Improvements on Vehicle Weight

Safety regulations developed by NHTSA in previous regulations may make compliance with the proposed standards more difficult or may reduce the projected benefits of the program. The primary way that safety regulations can impact fuel efficiency and GHG emissions is through increased vehicle weight, which reduces the fuel efficiency of the vehicle. Using MY 2010 as a baseline, this section discusses the effects of other government regulations on MY 2014–2016 medium- and heavy-duty vehicle fuel efficiency. At this time, no known safety standards will affect new models in MY 2017 or 2018. The agency's estimates are based on cost and weight tear-down studies of a few vehicles and cannot possibly cover all the variations in the manufacturers' fleets. NHTSA requested, and various manufacturers provided, confidential estimates of increases in weight resulting from safety improvements. Those increases are shown in subsequent tables.

We have broken down our analysis of the impact of safety standards that might affect the MY 2014–16 fleets into three parts: (1) Those NHTSA final rules with known effective dates, (2) proposed rules or soon to be proposed rules by NHTSA with or without final effective dates, and (3) currently voluntary safety improvements planned by the manufacturers.

(a) Weight Impacts of Required Safety Standards

NHTSA has undertaken several rulemakings in which several standards would become effective for medium-duty and heavy-duty (MD/HD) vehicles between MY 2014 and MY 2016. We will examine the potential impact on MD/HD vehicle weights for MY 2014–2016 using MY 2010 as a baseline. The following Federal Motor Vehicle Safety Standards (FMVSS) apply:

- FMVSS 119, Heavy Truck Tires Endurance and High Speed Tests.
- FMVSS 121, Air Brake Systems Stopping Distance.
- FMVSS 214, Motor Coach Lap/Shoulder Belts.
- MD/HD Vehicle Electronic Stability Control Systems.

(i) FMVSS 119, Heavy Truck Tires Endurance and High Speed Tests

The data in the large truck crash causation study and the agency's test results indicate that J and L load range tires are more likely to fail the proposed requirements among the targeted F, G, H, J and L load range tires.[424] As such the J and L load range tires specifically need to be addressed to meet the proposed requirements since the other load range tires are likely to pass the requirements. Rubber material improvements such as improving rubber compounds would be a countermeasure that reduces heat retention and improve the durability of the tires. Using high tensile strength steel chords in tire bead, carcass and belt would enable a weight reduction in construction with no strength penalties. The rubber material improvements and using high tensile strength steel would not add any additional weight to the current production heavy truck tires. Thus there may not be an incremental weight per

[424] "Preliminary Regulatory Impact Analysis, FMVSS No. 119, New Pneumatic Tires for Motor Vehicles with a GVWR of More Than 4,536 kg (10,000 pounds), June 2010.

vehicle for the period of MY 2014–2016 compared to the MY 2010 baseline. This proposal could become a final rule with an effective date of MY2016.

(ii) FMVSS No. 121, Airbrake Systems Stopping Distance

The most recent major final rule was published on July 27, 2009 and became effective on November 24, 2009 (MY2009) with different compliance dates. The final rule requires the vast majority of new heavy truck tractors (approximately 99 percent of the fleet) to achieve a 30 percent reduction in stopping distance compared to currently required levels. Three-axle tractors with GVWRat or below 59,600 pounds must meet the reduced stopping distance requirements by August 1, 2011 (MY2011). Two-axle tractors and tractors with GVWR above 59,600 pounds must meet the reduced stopping distance requirements by August 1, 2013 (MY2013). There are several brake systems that can meet the requirements in the final rule. Those systems include installation of larger S-cam drum brakes or disc brake systems at all positions, or hybrid disc and larger rear S-cam drum brake systems.

According to the data provided by a manufacturer (Bendix), the heaviest drum brakes weigh more than the lightest disc brakes while the heaviest disc brakes weigh more than the lightest drum brakes. For a three-axle tractor equipped with all disc brakes, the total weight could increase by 212 pounds or could decrease by 134 pounds, compared to an all drum braked tractor depending on which disc or drum brakes are used for comparison. The improved brakes may add a small amount of weight to the affected vehicle for MY2014–2016 resulting in a slight increase in fuel consumption.

(iii) FMVSS No. 208, Motor Coach Lap/Shoulder Belts

Based on preliminary results from the agency's cost/weight teardown studies of motor coach seats, it is estimated that the weight added by 3-point lap/shoulder belts ranges from 5.96 to 9.95 pounds per 2-person seat.[425] This is the weight only of the seat belt assembly itself and does not include changing the design of the seat, reinforcing the floor, walls or other areas of the motor coach. Few current production motor coaches have been installed with lap/shoulder belts on their seats, and the number could be negligible. Assuming a 54 passenger motor coach, the added weight for the 3-point lap/shoulder belt assembly is in the range of 161 to 269 pounds (27 * (5.96 to 9.95)) per vehicle. This proposal could become a final rule with an effective date of MY2016.

(iv) Electronic Stability Control Systems for Medium-Duty and Heavy-Duty (MD/HD) Vehicles

Electronic stability control systems are not currently required in MD/HD vehicles and could be proposed to be required in the vehicles by NHTSA. FMVSS No. 105, Hydraulic and electric brake systems, requires multipurpose passenger vehicles, trucks and buses with a GVWR greater than 4,536 kg (10,000 pounds) to be equipped with an antilock brake system. All MD/HD vehicles have a GVWR of more than 10,000 pounds, and these vehicles are required to be installed with an antilock brake system by the same standard.

Electronic stability control systems incorporate yaw rate control into the antilock brake system. Yaw is a rotation around the vertical axis. An electronic stability control system uses several sensors in addition to the sensors used in the antilock brake system, which is required in MD/HD vehicles. Those additional sensors could include steering wheel angle sensor, yaw rate sensor, lateral acceleration sensor and wheel speed sensor. According to the data provided by Meritor WABCO, the weight of the ESC for the model 4S4M tractor is estimated to be around 55.494 pounds, and the weight of the antilock brake system only is estimated to be 45.54 pounds. Then the added weight for an electronic stability control system for a vehicle is estimated to be 9.954 (55.494 − 45.54) pounds.

(b) Summary—Overview of Anticipated Weight Increases

Table VIII–23 summarizes estimates made by the agency regarding the weight added by the above discussed standards or likely rulemakings. The agency estimates that weight additions required by final rules and likely NHTSA regulations effective in MY 2016 compared to the MY 2010 fleet will increase motor coach vehicle weight by 171–279 pounds and will increase other heavy-duty truck weights by a minor 10 pounds.

Table VIII-23: Weight Additions Due to Final Rules or Likely NHTSA Regulations Comparing MY 2016 to the MY 2010 Baseline Fleet

Standard Number	Added Weight in pounds MD/HD Vehicle	Added Weight in kilograms MD/HD Vehicle
119	0	0
121	0 (?)	0 (?)
208 Motor coaches only	161-269	73-122
MD/HD Vehicle Electronic Stability Control Systems	10	4.5
Total Motor coaches	171- 279	77.5-126.5
Total All other MD/HD vehicles	10	4.5

[425] Cost and Weight Analysis of Two Motorcoach Seating Systems: One With and One Without Three-Point Lap/Shoulder Belt Restraints, Ludkes and Associates, July 2010.

(4) Effects of Vehicle Mass Reduction on Safety

NHTSA and EPA have been considering the effect of vehicle weight on vehicle safety for the past several years in the context of our joint rulemaking for light-duty vehicle CAFE and GHG standards, consistent with NHTSA's long-standing consideration of safety effects in setting CAFE standards. Combining all modes of impact, the latest analysis by NHTSA for the MYs 2012–2016 final rule found that reducing the weight of the heavier light trucks (LT > 3,870) had a positive overall effect on safety, reducing societal fatalities.[426]

In the context of the current rulemaking for HD fuel consumption and GHG standards, one would expect that reducing the weight of medium-duty trucks similarly would, if anything, have a positive impact on safety. However, given the large difference in weight between light-duty vehicles and medium-duty trucks, and even larger difference between light-duty vehicles and heavy-duty vehicles with loads, the agencies believe that the impact of weight reductions of medium- and heavy-duty trucks would not have a noticeable impact on safety for any of these classes of vehicles.

However, the agencies recognize that it is important to conduct further study and research into the interaction of mass, size and safety to assist future rulemakings, and we expect that the collaborative interagency work currently on-going to address this issue for the light-duty vehicle context may also be able to inform our evaluation of safety effects for the final HD vehicle rules. We seek comment regarding potential safety effects due to weight reduction in the HD vehicle context, with particular emphasis on commenters providing supporting data and research for HD vehicle weight reduction.

(5) Effects of the Proposal on Safety

Among all of the fuel efficiency improving technologies the agencies believe may be needed to achieve the proposed standards, NHTSA believes that tires are the only technology that might affect safety. For loaded trucks, there is little of no weather related (wet road) safety issue with reduced tire rolling resistance because of the high loads on the contact patch and high surface area of the contact patch. Within a fairly broad range (for rubber compounds) the tread material selection makes little difference in stopping distance for fully-loaded trucks. For unloaded trucks there can be a safety effect. On the other hand, tire manufacturers have introduced LRR steer and drive tires that perform very well, usually with more expensive materials and processes. High tensile steel wire constructions can make a carcass that is lighter without sacrificing strength. New grades of carbon black and other reinforcing fillers continue to be developed that lower weight and/or hysteresis without sacrificing other properties. With a cost increase, tires can be made lighter and tires can be made with lower rolling resistance without sacrificing safety. While the design of the body or carcass of tires does affect rolling resistance, because of market demands, it is unlikely that manufacturers of tires are going to make significant changes to the body or carcass of the tire that would affect safety. NHTSA is close to issuing an NPRM on an upgrade to FMVSS No. 119 for heavy truck tires that may result in better carcass construction.

Related to effects of the proposal on retread tires, the NPRM only regulates original equipment (new vehicle) tires. The proposed rules would not regulate replacement or retread tires. The only way the rules would affect retreading of tires is if the original equipment body or carcass is modified to improve rolling resistance. Again, because of market demands, it is unlikely that manufacturers of tires are going to make significant changes to the body or carcass of the tire that would affect safety. Although not regulated by this proposal, the tread used for retreaded tires can be made with lower rolling resistance without sacrificing safety at a cost, if the market demands it.

The agency seeks comments on the safety effects of LRR tires for trucks.

K. Summary of Costs and Benefits From the Greenhouse Gas Emissions Perspective

As noted in Section VIII.A, the primary motivations of this proposal are improved energy security and GHG emissions reductions in the United States. From that perspective, the benefits of the proposal are the external effects, and the net effects on truck owners and operators are the costs. In this section, the agencies present a summary of costs, benefits, and net benefits of the proposal. Section VIII.L presents the benefits and costs from the perspective that the motivation of the program is to improve fuel efficiency.

Table VIII–24 shows the estimated annual monetized costs of the proposed program for the indicated calendar years. The table also shows the net present values of those costs for the calendar years 2012–2050 using both 3 percent and 7 percent discount rates.[417] In this table, the aggregate value of fuel savings is calculated using pre-tax fuel prices since savings in fuel taxes do not represent a reduction in the value of economic resources utilized in producing and consuming fuel. Note that fuel savings shown here result from reductions in fleet-wide fuel use. Thus, they grow over time as an increasing fraction of the fleet meets the 2018 standards.

[426] "Final Regulatory Impact Analysis, Corporate Average Fuel Economy for MY 2012–MY 2016 Passenger Cars and Light Trucks", NHTSA, March 2010, (Docket No. NHTSA–2009–0059–0344.1).

[417] For the estimation of the stream of costs and benefits, we assume that after implementation of the proposed MY 2014–2017 standards, the 2017 standards apply to each year out to 2050.

Table VIII-24: Estimated Monetized Costs of the Proposed Program (Millions of 2008 dollars)[a]

	2020	2030	2040	2050	NPV, Years 2012-2050, 3% Discount Rate	NPV, Years 2012-2050, 7% Discount Rate
Technology Costs	$2,000	$1,900	$2,200	$2,500	$42,100	$22,500
Fuel Savings (pre-tax)	-$8,100	-$19,000	-$28,100	-$35,400	-$352,300	-$152,600
Monetized Annual Costs	-$6,100	-$17,100	-$25,900	-$32,900	-$310,200	-$130,100

Note:
[a] Technology costs and fuel savings for separate truck segments can be found in Section 8.3.

Table VIII–25 presents estimated annual monetized benefits for the indicated calendar years. The table also shows the net present values of those benefits for the calendar years 2012–2050 using both 3 percent and 7 percent discount rates. The table shows the benefits of reduced CO_2 emissions—and consequently the annual quantified benefits (*i.e.*, total benefits)—for each of four SCC values estimated by the interagency working group. As discussed in the RIA Section 8.5, there are some limitations to the SCC analysis, including the incomplete way in which the integrated assessment models 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.

In addition, these monetized GHG benefits exclude the value of net reductions in non-CO_2 GHG emissions (CH_4, N_2O, HFC) expected under this proposal. Although EPA has not monetized the benefits of reductions in non-CO_2 GHGs, the value of these reductions should not be interpreted as zero. Rather, the net reductions in non-CO_2 GHGs will contribute to this proposal's climate benefits, as explained in Section VI.C.

Table VIII-25: Monetized Benefits Associated with the Proposed Program (Million 2008 dollars)

	2020	2030	2040	2050	NPV, Years 2012-2050, 3% Discount Rate[a]	NPV, Years 2012-2050, 7% Discount Rate[a]
Reduced CO_2 Emissions at each assumed SCC value [b]						
5% (avg SCC)	$200	$700	$1,200	$1,700	$8,600	$8,600
3% (avg SCC)	$900	$2,300	$3,600	$4,900	$44,000	$44,000
2.5% (avg SCC)	$1,500	$3,500	$5,300	$7,100	$74,600	$74,600
3% (95th percentile)	$2,800	$7,100	$10,800	$14,800	$134,100	$134,100
Energy Security Impacts (price shock)	$500	$1,100	$1,500	$1,800	$19,800	$8,700
Accidents, Congestion, Noise	-$200	-$400	-$500	-$600	-$7,500	-$3,400
Refueling Savings	$100	$100	$200	$200	$2,500	$1,100
Non-CO_2 GHG Impacts and Non-GHG Impacts [c,d]	n/a	n/a	n/a	n/a	n/a	n/a
Total Annual Benefits at each assumed SCC value [b]						
5% (avg SCC)	$600	$1,500	$2,400	$3,100	$23,400	$15,000
3% (avg SCC)	$1,300	$3,100	$4,800	$6,300	$58,800	$50,400
2.5% (avg SCC)	$1,900	$4,300	$6,500	$8,500	$89,400	$81,000
3% (95[th] percentile)	$3,200	$7,900	$12,000	$16,200	$148,900	$140,500

Notes:

[a] 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 (SCC 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.

[b] Section VIII.G notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $22-$46; for Average SCC at 2.5%: $36-$66; and for 95[th] percentile SCC at 3%: $66-$139. *See* Section VIII.F.

[c] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this proposal (S*ee* RIA Chapter 5). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero.

[d] Non-GHG-related health and welfare impacts (related to $PM_{2.5}$ and ozone exposure) were not estimated for this proposal, but will be included in the analysis of the final rulemaking.

Table VIII–26 presents estimated annual net benefits for the indicated calendar years. The table also shows the net present values of those net benefits for the calendar years 2012–2050 using both 3 percent and 7 percent discount rates. The table includes the benefits of reduced CO_2 emissions (and consequently the annual net benefits) for each of four SCC values considered by EPA.

Table VIII-26: Monetized Net Benefits Associated with the Proposed Program (Million 2008 dollars)

	2020	2030	2040	2050	NPV, 3%[a]	NPV, 7%[a]
Total Annual Costs[b]						
Total Annual Costs	-$6,1000	-$17,100	-$25,900	-$32,900	-$310,200	-$130,100
Total Annual Benefits at each assumed SCC value[c]						
5% (avg SCC)	$600	$1,500	$2,400	$3,100	$23,400	$15,000
3% (avg SCC)	$1,300	$3,100	$4,800	$6,300	$58,800	$50,400
2.5% (avg SCC)	$1,900	$4,300	$6,500	$8,500	$89,400	$81,000
3% (95th percentile)	$3,200	$7,900	$12,000	$16,200	$148,900	$140,500
Monetized Net Benefits at each assumed SCC value[c]						
5% (avg SCC)	$6,7000	$18,600	$28,300	$36,000	$333,600	$145,100
3% (avg SCC)	$7,400	$20,200	$30,700	$39,200	$369,000	$180,500
2.5% (avg SCC)	$8,000	$21,400	$32,400	$41,400	$399,600	$211,100
3% (95th percentile)	$9,300	$25,000	$37,900	$49,100	$459,100	$270,600

Notes:

[a] 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 (SCC 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.

[b] Negative costs represent savings.

[c] Section VIII.G notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $22-$46; for Average SCC at 2.5%: $36-$66; and for 95th percentile SCC at 3%: $66-$139. Section VIII.G also presents these SCC estimates.

EPA also conducted a separate analysis of the total benefits over the model year lifetimes of the 2014 through 2018 model year trucks. In contrast to the calendar year analysis presented above in Table VIII–24 through Table VIII–26, the model year lifetime analysis below shows the impacts of the proposed program on vehicles produced during each of the model years 2014 through 2018 over the course of their expected lifetimes. The net societal benefits over the full lifetimes of vehicles produced during each of the five model years from 2014 through 2018 are shown in Table VIII–27 and Table VIII–28 at both 3 percent and 7 percent discount rates, respectively.

Table VIII-27: Monetized Costs, Benefits, and Net Benefits Associated with the Lifetimes of 2014-2018 Model Year Trucks (Millions of 2008 dollars; 3% Discount Rate)

	2014 MY	2015 MY	2016 MY	2017 MY	2018 MY	Sum
Technology	-$1,300	-$1,300	-$1,500	-$1,600	-$2,000	-$7,700
Fuel Savings (pre-tax)	$6,100	$6,400	$7,200	$10,700	$11,900	$42,300
Energy Security Impacts (price shock)	$400	$400	$400	$600	$700	$2,500
Accidents, Congestion, Noise	-$300	-$300	-$300	-$300	-$300	-$1,400
Refueling Savings	$200	$200	$200	$200	$200	$1,100
Non-CO_2 GHG Impacts and Non-GHG Impacts [c,d]	n/a	n/a	n/a	n/a	n/a	n/a
Reduced CO_2 Emissions at each assumed SCC value [a, b]						
5% (avg SCC)	$200	$200	$200	$300	$300	$1,200
3% (avg SCC)	$600	$600	$700	$1,000	$1,200	$4,100
2.5% (avg SCC)	$1,000	$1,000	$1,100	$1,600	$1,800	$6,500
3% (95th percentile)	$1,900	$2,000	$2,200	$3,200	$3,500	$12,800
Monetized Net Benefits at each assumed SCC value [a, b]						
5% (avg SCC)	$5,300	$5,600	$6,200	$9,900	$10,800	$38,000
3% (avg SCC)	$5,700	$6,000	$6,700	$10,600	$11,700	$40,900
2.5% (avg SCC)	$6,100	$6,400	$7,100	$11,200	$12,300	$43,300
3% (95th percentile)	$7,000	$7,400	$8,200	$12,800	$14,000	$49,600

Notes:

[a] 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 (SCC 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.

[b] Section VIII.G notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $22-$46; for Average SCC at 2.5%: $36-$66; and for 95th percentile SCC at 3%: $66-$139. Section VIII.G also presents these SCC estimates.

[c] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this proposal (see RIA Chapter 5). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero.

[d] Non-GHG-related health and welfare impacts (related to $PM_{2.5}$ and ozone exposure) were not estimated for this proposal, but will be included in the analysis of the final rulemaking.

Table VIII-28: Monetized Costs, Benefits, and Net Benefits Associated with the Lifetimes of 2014-2018 Model Year Trucks (Millions of 2008 dollars; 7% Discount Rate)

	2014 MY	2015 MY	2016 MY	2017 MY	2018 MY	Sum
Technology	-$1,300	-$1,300	-$1,500	-$1,600	-$2,000	-$7,700
Fuel Savings (pre-tax)	$4,500	$4,500	$4,900	$7,000	$7,500	$28,400
Energy Security Impacts (price shock)	$300	$300	$300	$400	$400	$1,700
Accidents, Congestion, Noise	-$200	-$200	-$200	-$200	-$200	-$900
Refueling Savings	$200	$200	$200	$200	$200	$900
Non-CO_2 GHG Impacts and Non-GHG Impacts [c,d]	n/a	n/a	n/a	n/a	n/a	n/a
Reduced CO_2 Emissions at each assumed SCC value [a, b]						
5% (avg SCC)	$200	$200	$200	$300	$300	$1,200
3% (avg SCC)	$600	$600	$700	$1,000	$1,200	$4,100
2.5% (avg SCC)	$1,000	$1,000	$1,100	$1,600	$1,800	$6,500
3% (95th percentile)	$1,900	$2,000	$2,200	$3,200	$3,500	$12,800
Monetized Net Benefits at each assumed SCC value [a, b]						
5% (avg SCC)	$3,700	$3,700	$3,900	$6,100	$6,200	$23,600
3% (avg SCC)	$4,100	$4,100	$4,400	$6,800	$7,100	$26,500
2.5% (avg SCC)	$4,500	$4,500	$4,800	$7,400	$7,700	$28,900
3% (95th percentile)	$5,400	$5,500	$5,900	$9,000	$9,400	$35,200

Notes:

[a] 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 (SCC 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.

[b] Section VIII.G notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $22-$46; for Average SCC at 2.5%: $36-$66; and for 95th percentile SCC at 3%: $66-$139. Section VIII.G also presents these SCC estimates.

[c] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this proposal (see RIA Chapter 5). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero.

[d] Non-GHG-related health and welfare impacts (related to $PM_{2.5}$ and ozone exposure) were not estimated for this proposal, but will be included in the analysis of the final rulemaking.

L. Summary of Costs and Benefits From the Fuel Efficiency Perspective

The purpose of a program to regulate fuel efficiency is primarily to save fuel, as compared to the purpose of a program to regulate GHG emissions, which is primarily to reduce the impact of climate change. Considering costs and benefits from a fuel efficiency perspective, technology costs occur when the vehicle is purchased, just as they do from a GHG emissions perspective, but fuel savings would be counted as benefits that occur over the lifetime of the vehicle as it consumes less fuel, rather than as negative costs that would be experienced either at the time of purchase or over the lifetime of the vehicle. Tables VIII–29 and VIII–30 show the same estimates as provided in Tables VIII–27 and VIII–28, but with the categories relabeled to illustrate the fuel efficiency perspective.

Table VIII-29 Monetized Costs, Benefits, and Net Benefits Associated with the Lifetimes of 2014-2018 Model Year Trucks (Millions of 2008 dollars; 3% Discount Rate)

	2014 MY	2015 MY	2016 MY	2017 MY	2018 MY	Sum
Technology Costs	$1,300	$1,300	$1,500	$1,600	$2,000	$7,700
Benefits						
Fuel Savings (pre-tax)	$6,100	$6,400	$7,200	$10,700	$11,900	$42,300
Energy Security Impacts (price shock)	$400	$400	$400	$600	$700	$2,500
Accidents, Congestion, Noise	-$300	-$300	-$300	-$300	-$300	-$1,400
Refueling Savings	$200	$200	$200	$200	$200	$1,100
Non-CO_2 GHG Impacts and Non-GHG Impacts [c,d]	n/a	n/a	n/a	n/a	n/a	n/a
Reduced CO_2 Emissions at each assumed SCC value [a, b]						
5% (avg SCC)	$200	$200	$200	$300	$300	$1,200
3% (avg SCC)	$600	$600	$700	$1,000	$1,200	$4,100
2.5% (avg SCC)	$1,000	$1,000	$1,100	$1,600	$1,800	$6,500
3% (95th percentile)	$1,900	$2,000	$2,200	$3,200	$3,500	$12,800
Monetized Net Benefits at each assumed SCC value [a, b]						
5% (avg SCC)	$5,300	$5,600	$6,200	$9,900	$10,800	$38,000
3% (avg SCC)	$5,700	$6,000	$6,700	$10,600	$11,700	$40,900
2.5% (avg SCC)	$6,100	$6,400	$7,100	$11,200	$12,300	$43,300
3% (95th percentile)	$7,000	$7,400	$8,200	$12,800	$14,000	$49,600

Notes:

[a] 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 (SCC 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.

[b] Section VIII.G notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $22-$46; for Average SCC at 2.5%: $36-$66; and for 95th percentile SCC at 3%: $66-$139. Section VIII.G also presents these SCC estimates.

[c] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this proposal (see RIA Chapter 5). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero.

[d] Non-GHG-related health and welfare impacts (related to $PM_{2.5}$ and ozone exposure) were not estimated for this proposal, but will be included in the analysis of the final rulemaking.

Table VIII-30 Monetized Costs, Benefits, and Net Benefits Associated with the Lifetimes of 2014-2018 Model Year Trucks (Millions of 2008 dollars; 7% Discount Rate)

	2014 MY	2015 MY	2016 MY	2017 MY	2018 MY	Sum
Technology Costs	$1,300	$1,300	$1,500	$1,600	$2,000	$7,700
Benefits						
Fuel Savings (pre-tax)	$4,500	$4,500	$4,900	$7,000	$7,500	$28,400
Energy Security Impacts (price shock)	$300	$300	$300	$400	$400	$1,700
Accidents, Congestion, Noise	-$200	-$200	-$200	-$200	-$200	-$900
Refueling Savings	$200	$200	$200	$200	$200	$900
Non-CO_2 GHG Impacts and Non-GHG Impacts [c,d]	n/a	n/a	n/a	n/a	n/a	n/a
Reduced CO_2 Emissions at each assumed SCC value [a, b]						
5% (avg SCC)	$200	$200	$200	$300	$300	$1,200
3% (avg SCC)	$600	$600	$700	$1,000	$1,200	$4,100
2.5% (avg SCC)	$1,000	$1,000	$1,100	$1,600	$1,800	$6,500
3% (95th percentile)	$1,900	$2,000	$2,200	$3,200	$3,500	$12,800
Monetized Net Benefits at each assumed SCC value [a, b]						
5% (avg SCC)	$3,700	$3,700	$3,900	$6,100	$6,200	$23,600
3% (avg SCC)	$4,100	$4,100	$4,400	$6,800	$7,100	$26,500
2.5% (avg SCC)	$4,500	$4,500	$4,800	$7,400	$7,700	$28,900
3% (95th percentile)	$5,400	$5,500	$5,900	$9,000	$9,400	$35,200

Notes:

[a] 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 (SCC 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.

[b] Section VIII.G notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $22-$46; for Average SCC at 2.5%: $36-$66; and for 95th percentile SCC at 3%: $66-$139. Section VIII.G also presents these SCC estimates.

[c] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this proposal (see RIA Chapter 5). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero.

[d] Non-GHG-related health and welfare impacts (related to $PM_{2.5}$ and ozone exposure) were not estimated for this proposal, but will be included in the analysis of the final rulemaking.

IX. Analysis of Alternatives

The heavy-duty truck segment is very complex. The sector consists of a diverse group of impacted parties, including engine manufacturers, chassis manufacturers, truck manufacturers, trailer manufacturers, truck fleet owners and the air breathing public. The proposal the agencies have laid out today is largely shaped to maximize the environmental and fuel savings benefits of the program respecting the unique and varied nature of the regulated industries. In developing this proposal, we considered a number of alternatives that could have resulted in fewer or potentially greater GHG and fuel consumption reductions than the program we are proposing. This section summarizes the alternatives we considered and presents assessments of technology costs, CO2 reductions, and fuel savings associated with each alternative. The agencies request comments on all of these alternatives, including whether a specific alternative could achieve greater net benefits than the preferred alternative, either for all regulatory categories, or for any individual regulatory category. The agencies also request comments on whether any specific additional analyses could provide information that could further inform the selection among alternatives for the final rule.

A. What are the alternatives that the agencies considered?

In developing alternatives, NHTSA must consider EISA's requirement for the MD/HD fuel efficiency program noted above. 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.

Each of the alternatives proposed by NHTSA and EPA represents, in part, a different way the agencies could establish a HD program pursuant to EISA and the CAA. The agencies are proposing Alternative 6. The alternatives below represent a broad range of approaches under consideration for setting proposed HD vehicle fuel efficiency and GHG emissions standards. A simplified table describing the alternatives is included in Table IX–1, in Section IX. A. (9) below. The alternatives that the agencies are proposing, in order of increasing fuel efficiency and GHG emissions reductions, are:

(1) Alternative 1: No Action

A "no action" alternative assumes that the agencies would not issue rules regarding a MD/HD fuel efficiency improvement program, and is considered to comply with the National Environmental Policy Act (NEPA) and to provide an analytical baseline against which to compare environmental impacts of the other regulatory alternatives.[418] The agencies refer to this as the "No Action Alternative" or as a "no increase" or "baseline" alternative.

(2) Alternative 2: Engine Only

The EPA currently regulates heavy-duty engines, *i.e.*, engine manufacturers, rather than the vehicle as a whole, in order to control criteria emissions.[429] Under Alternative 2, the agencies would similarly set engine performance standards for each vehicle class, Class 2b through Class 8, and would specify an engine cell test procedure, as EPA currently does for criteria pollutants. HD engine manufacturers would be responsible for ensuring that each engine could meet the applicable vehicle class engine performance standard when tested in accordance with the specified engine cell test procedure. Engine manufacturers could improve HD engines by applying the combinations of fuel efficiency improvements and GHG emissions reduction technologies to the engine that they deem best achieve that result.

(3) Alternative 3: Class 8 Combination Tractors

Combination tractors consume the largest fraction of fuel within the heavy-duty truck segment. Tractors also offer significant potential for fuel savings due to the high annual mileage and high vehicle speed of typical trucks within this segment, as compared to annual mileage and average speeds/duty cycles of other vehicle categories. This alternative would set performance standards for both the engine of Class 8 vehicles and the overall vehicle efficiency performance for the Class 8 combination tractor segment. Under Alternative 3, the agencies would set an engine performance standard, as discussed under Alternative 2, for Class 8 tractors. In addition, Class 8 combination tractor manufacturers would be required to meet an overall vehicle performance standard by making various non-engine fuel saving technology improvements. These non-engine fuel efficiency and GHG emissions improvements could be accomplished, for example, by a combination of improvements to aerodynamics, lowering tire rolling resistance, decreasing vehicle mass (weight), reducing fuel use at idle, or by adding intelligent vehicle technologies.[430] Compliance with the overall vehicle standard could be determined using a computer model that would simulate overall vehicle fuel efficiency given a set of vehicle component inputs. Using this compliance approach, the Class 8 vehicle manufacturer would supply certain vehicle characteristics (relating to the categories of technologies noted immediately above) that would serve as model inputs. The agency would supply a standard Class 8 vehicle engine's contribution to overall vehicle efficiency, making the engine component a constant for purposes of compliance with the overall vehicle performance standard, such that compliance with the overall vehicle standard could only be achieved via efficiency improvements to non-engine vehicle components. Thus, vehicle manufacturers could make any combination of improvements of the non-engine technologies that they believe would best achieve the Class 8 overall vehicle performance standard.

(4) Alternative 4: Engines and Class 7 and 8 Tractors

This alternative combines Alternative 2 with Alternative 3, and additionally would set an overall vehicle efficiency performance standard for Class 7 tractors. This alternative would, thus, set standards for all HD engines and would set overall vehicle performance standards for Class 7 and 8 tractors, as described for Class 8 combination tractors under Alternative 3. Class 7 tractors make up a small percent of the tractor market, approximately 9 percent.[431] Though the segment is currently small, the agencies believe the inclusion of this subcategory of vehicles would help prevent a potential class shifting, as noted in the NAS panel report.[432]

(5) Alternative 5: Engines, Class 7 and 8 Tractors, and HD Pickup Trucks and Vans

This alternative builds on Alternative 4 through the addition of an overall vehicle efficiency performance standard for HD Pickup Trucks and Vans (or work trucks). Therefore, under this alternative, the agencies would set engine performance standards for each HD vehicle class, and would also set overall vehicle performance standards for Class 7 and 8 tractors, as well as for HD Pickup Trucks and Vans. Compliance for the HD pickup trucks and vans would be determined through a fleet averaging process similar to determining passenger car and light truck compliance with CAFE standards.

(6) Alternative 6: Engines, Tractors, and Class 2b Through 8 Trucks

Alternative 6 represents the agencies' preferred approach. This alternative would set engine efficiency standards, engine GHG emissions standards,

[418] 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. It is also an example of a reasonable alternative outside the jurisdiction of the agency which must be analyzed. (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 (emphasis added).

[429] There are several reasons for this approach. In many cases the engine and chassis are produced by different manufacturers and it is more efficient to hold a single entity responsible. Also, testing an engine cell is more accurate and repeatable than testing a whole vehicle.

[430] *See* the NAS Report, Note 111, above, at Chapter 5, for discussions of the potential fuel efficiency improvement technologies that can be applied to each of these vehicle components.

[431] MJ Bradley. Heavy-duty Vehicle Market Analysis. May 2009.

[432] *See* NAS Report, Note 111, above, at page 152.

overall vehicle fuel efficiency standards, and overall vehicle GHG emissions standards for HD pickup trucks and vans and the remaining Class 2b through Class 8 vehicles and the engines installed in them. This alternative essentially sets fuel efficiency and GHG emissions performance standards for both the engines and the overall vehicles in the entire heavy-duty truck sector. Compliance with each vehicle category's engine performance standard would be determined as discussed in the description of Alternative 2. Compliance with the tractor and vocational vehicle categories' overall vehicle performance standard (Class 2b through 8 vehicles) would be determined as discussed in the description of Alternative 3. Compliance for the HD pickup trucks and vans as described in Alternative 5.

The agencies also evaluated two scenarios related to Alternative 6 but with stringency levels which were 20 percent more and less stringent. These alternatives are referred to as Alternatives 6a and 6b. The agencies welcome comment on other approaches to develop and present additional stringency alternatives.

(a) Alternative 6a: Engines, Tractors, and Class 2b Through 8 Trucks

Alternative 6a represents an alternative stringency level to the agencies' preferred approach. Like Alternative 6, this alternative would set GHG emissions and fuel efficiency standards for HD pickup trucks and vans and for Class 2b through 8 vocational vehicles and combination tractors and the engines installed in them. The difference between Alternative 6 and 6a is the level of stringency for each of the proposed standards. Alternative 6a represents a stringency level which is approximately15 percent less stringent than the preferred approach. The agencies calculated the stringency level in order to meet two goals. First, we desired to create an alternative that was closely related to the proposal (within 10–20 percent of the preferred alternative). Second, we wanted an alternative that reflected removal of the last technology we believed manufacturers would add in order to meet the preferred alternative. In other words, we wanted an alternative that as closely as possible reflected the last increment in stringency prior to reaching our preferred alternative. In general, this could be thought of as removing the least cost effective (final) step. The resulting Alternative 6a is based on the same technologies used in Alternative 6 except as follows:

- Combination tractor standard would be based removal of the Advanced SmartWay aerodynamic package and weight reduction technologies which reduces the average combination tractor savings by approximately 1 percent;
- HD pickup truck and van standard would be based on removal of aerodynamics which reduces the average truck savings by approximately 2 percent; and
- Vocational vehicle standard would be based on removal of low rolling resistant tires which reduces the average vehicle savings by approximately 2 percent.

(b) Alternative 6b: Engines, Tractors, and Class 2b Through 8 Trucks

Alternative 6b represents an alternative stringency level to the agencies' preferred approach. Like Alternative 6, this alternative would set GHG emissions and fuel efficiency standards for HD pickup trucks and vans and for Class 2b through 8 vocational vehicles and combination tractors and the engines installed in them. The difference between Alternative 6 and 6b is the level of stringency for each of the proposed standards. Alternative 6b represents a stringency level which is approximately 20 percent more stringent than the preferred approach. The agencies calculated the stringency level based on similar goals as for Alternative 6a. Specifically, we wanted an alternative that would reflect an incremental improvement over the preferred alternative based on the technologies we thought most likely to be applied by manufacturers if a more stringent standard were set. In general, this could be thought of as adding the next most cost effective technology in each of the categories. However, as discussed in the feasibility discussions in Section III, we are not proposing this level of stringency because we do not believe that these technologies can be developed and introduced in the timeframe of this rulemaking. Reflecting that given unlimited resources it might be possible to introduce these technologies in this timeframe, but our inability to estimate what those real costs might be (*e.g.* to build new factories in only one to two years), we have denoted the cost for this alternative with a +c. The +c is intended to make clear that the cost estimates we are showing do not include additional costs related to pulling ahead the development and expanding manufacturing base for these technologies. The resulting Alternative 6b is based on the same technologies used in Alternative 6 except as follows:

- Combination tractor standard would be based on the addition of Rankine waste heat recovery to the HD engines installed in combination tractors with sleeper cabs;
- HD pickup truck and van standard would be based on the addition of a 10 percent mass reduction; and
- Vocational vehicle standard would be based on the addition hybrid powertrains to 8 percent of the vehicles.

(7) Alternative 7: Engines, Tractors, Trucks, and Trailers

This alternative builds on Alternative 6 by adding a performance standard for fuel efficiency and GHG emissions of commercial trailers. Therefore, this alternative would include fuel efficiency performance standards and GHG emissions standards for Class 2b and 3 work truck and Class 3 through Class 8 vocational vehicle engines, and the performance standards for the overall fuel efficiency and GHG emissions of those vehicles, as described above.

(8) Alternative 8: Engines, Tractors, Trucks, and Trailers Plus Advanced Hybrid Powertrain Technology for Vocational Vehicles, Pickups, and Vans

Alternative 8 includes all elements of Alternative 7, plus sets standards based on the application of hybrid powertrains to heavy-duty pickup trucks, vans, and vocational vehicles. The application of hybrids is capped at 10,000 units annually for model years 2014–2016 (more than double the industry's sales projections for 2010) and increases to 50 percent of new vehicles in those categories starting in 2017, or approximately 650,000 hybrid powertrain units annually. The agencies do not believe that it is possible to achieve hybrid technology penetration rates at or even near these levels in the timeframe of this rulemaking. However, we believe it is useful to consider what a future standard based on the use of such advanced technologies could achieve. Similarly, we cannot, with confidence, project the cost of doing so in this timeframe. Nevertheless for the purpose of evaluating what additional benefits could be achieved if such a program were possible, we believe this Alternative 8 is useful for consideration. The assumed standard and commensurate fuel consumption and emission reductions for this alternative are based on a 25 percent reduction in CO_2 and fuel consumption with the application of hybrid powertrain technology. The actual benefit realized through the application of hybrid technology is highly dependent on vehicle drive cycle and can vary significantly between different applications. The 25 percent reduction assumed here is based on the estimate of the NAS panel for a hybrid refuse truck.[433] Although the agencies are not able to conclude that this alternative is technically feasible and therefore potentially appropriate to be finalized as a regulatory requirement, we have made an estimate of the cost for this approach based on the estimates from the NAS report. Specifically we are assuming an incremental cost of $30,000 per vehicle for vocational vehicles based again on the NAS estimate for a refuse truck and an incremental cost of $9,000 per vehicle for HD pickup trucks and vans. As with Alternative 6b, we include a +c in our cost estimates for this alternative to reflect additional costs not estimated by the agencies.

(9) Summary of Alternatives

A summary of the combination of vehicles regulated under each proposed alternative is included in Table IX–1.

Table IX-1: Summary of Alternatives

Approach	Vehicle Category	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
Engines	Cl. 2b-8	-	●	Cl. 8 Only	●	●	●	●	●
Vehicles	Pickups and Vans	-				●	●	●	●
	Cl. 2b-8 Vocational Vehicles	-					●	●	●
	Cl. 7-8 Tractors	-		Cl. 8 Only	●	●	●	●	●
Trailers								●	●

B. How do these alternatives compare in overall GHG emissions reductions, fuel efficiency and cost?

The agencies analyzed all ten alternatives through MOVES to evaluate the impact of each proposed alternative, as shown in Table IX–2. The table contains the annual CO_2 and fuel savings in 2030 and 2050 for each alternative (relative to the reference scenario of Alternative 1), presenting both the total savings across all regulatory categories, and for each regulatory category. Table IX–3 presents the annual technology costs associated with each alternative (relative to the reference scenario of Alternative 1) in 2030 and 2050 for each regulatory category. In addition, the net benefits for each alternative in 2030 and 2050 are included in Tables IX–4 and IX–5, respectively. The agencies request comment on whether any of these alternatives could achieve greater net benefits than the preferred alternative, either for all regulatory categories, or for any individual regulatory category.

In analyzing the marginal economic impact of each of the alternatives relative to one another, or relative to the preferred Alternative 6, various potentially relevant time frames and frames of reference for analysis could be employed. For example, it may be relevant to consider the impacts of an alternative not only in 2030 and 2050, but also in 2020. Likewise, it may be relevant to consider not just total annual impacts on the entire fleet in a given year, but also the NPV impacts on the specific MY vehicles that are to be directly regulated in this rulemaking (*i.e.* MY 2014–2018). The agencies also request comments on the time frames of (*e.g.* 2014–2018, 2030, or 2050), and frames of reference for, economic analyses of alternatives that commenters believe are relevant in evaluating the incremental impact of the agencies' preferred alternative 6, relative to the other alternative examined.

[433] *See* NAS Report, Note 111 above, at 77.

Table IX-2: Annual CO_2 and Oil Savings in 2030 and 2050

	Downstream CO_2 Savings (MMT)		Oil Savings (billion gallons)	
	2030	2050	2030	2050
Alt. 1	0	0	0	0
Alt. 2 – Total	29	46	2.9	4.6
Tractors	19	27	1.8	2.6
HD Pickup Trucks	4	7	0.4	0.7
Vocational Vehicles	6	13	0.6	1.2
Alt. 3 – Total	35	50	3.4	4.9
Tractors	35	50	3.4	4.9
HD Pickup Trucks	0	0	0	0
Vocational Vehicles	0	0	0	0
Alt. 4 – Total	50	76	5.0	7.5
Tractors	40	57	3.9	5.6
HD Pickup Trucks	4	7	0.4	0.7
Vocational Vehicles	6	13	0.6	1.2
Alt. 5 – Total	54	82	5.4	8.2
Tractors	40	57	3.9	5.6
HD Pickup Trucks	8	13	0.8	1.3
Vocational Vehicles	6	13	0.6	1.2
Alt. 6a – Total	52	79	5.1	7.8
Tractors	39	56	3.8	5.5
HD Pickup Trucks	7	11	0.7	1.1
Vocational Vehicles	6	13	0.6	1.2
Preferred – Total	58	91	5.8	9.0
Tractors	40	57	3.9	5.6
HD Pickup Trucks	8	13	0.8	1.3
Vocational Vehicles	10	21	1.0	2.1
Alt. 6b – Total	68	107	6.7	10.6
Tractors	46	65	4.5	6.4
HD Pickup Trucks	9	15	1.0	1.6
Vocational Vehicles	13	27	1.3	2.6
Alt. 7 – Total	62	96	6.1	9.5
Tractors	40	57	3.9	5.6
HD Pickup Trucks	8	13	0.8	1.3
Vocational Vehicles	10	21	1.0	2.1
Trailers	4	5	0.4	0.5
Alt. 8 – Total	86	142	8.4	14.2
Tractors	40	57	3.9	5.6
HD Pickup Trucks	16	25	1.6	2.7
Vocational Vehicles	26	55	2.5	5.4
Trailers	4	5	0.4	0.5

Table IX-3: Technology Cost Projections for the Alternatives

	Technology costs (2008$ millions)	
	2030	2050
Alt. 1	$0	$0
Alt. 2 – Total	$532	$749
Tractors	$119	$157
HD Pickup Trucks	$235	$273
Vocational Vehicles	$178	$319
Alt. 3 – Total	$708	$938
Tractors	$708	$938
HD Pickup Trucks	$0	$0
Vocational Vehicles	$0	$0
Alt. 4 – Total	$1,155	$1,574
Tractors	$742	$982
HD Pickup Trucks	$235	$273
Vocational Vehicles	$178	$319
Alt. 5 – Total	$1,882	$2,420
Tractors	$742	$982
HD Pickup Trucks	$962	$1,119
Vocational Vehicles	$178	$319
Alt. 6a – Total	$1,592	$2,041
Tractors	$487	$645
HD Pickup Trucks	$927	$1,078
Vocational Vehicles	$178	$319
Preferred – Total	$1,945	$2,537
Tractors	$742	$982
HD Pickup Trucks	$962	$1,119
Vocational Vehicles	$241	$436
Alt. 6b – Total [a]	$4,984+c	$7,575+c
Tractors	$1,375+c	$1,819+c
HD Pickup Trucks	$1,301+c	$1,514+c
Vocational Vehicles	$2,307+c	$4,241+c
Alt. 7 – Total	$2,885	$3,740
Tractors	$742	$982
HD Pickup Trucks	$962	$1,119
Vocational Vehicles	$241	$436
Trailers	$910	$1,203
Alt. 8 – Total	$35,477 +c	$59,000+c
Tractors	$742	$982
HD Pickup Trucks	$7,760 +c	$8,809+c
Vocational Vehicles	$26,065+c	$48,006+c
Trailers	$910	$1,203

Notes:
[a] "+c" indicates additional costs not estimated in this proposal.

Table IX-4: Monetized Net Benefits Associated with Each Alternative in 2030 (Million 2008 dollars)

	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5	Alt.6a	Alt.6	Alt.6b	Alt.7	Alt.8
Technology Costs [e]	$0	-$500	-$700	-$1,200	-$1,900	-$1,600	-$1,900	-$5,000 +c	-$2,900	-$35,500 +c
Fuel Savings (pre-tax)	$0	$9,400	$11,300	$16,400	$17,600	$16,800	$19,000	$22,100	$20,100	$27,700
Energy Security Impacts (price shock)	$0	$600	$700	$1,000	$1,000	$1,000	$1,100	$1,300	$1,200	$1,600
Accidents, Congestion, Noise	$0	-$200	-$200	-$300	-$400	-$400	-$400	-$500	-$400	-$600
Refueling Savings	$0	$70	$60	$110	$130	$120	$100	$170	$150	$230
Non-CO_2 GHG Impacts and Non-GHG Impacts [c,d]	$0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reduced CO_2 Emissions at each assumed SCC value [a, b]										
5% (avg SCC)	$0	$300	$400	$600	$600	$600	$700	$800	$700	$1,000
3% (avg SCC)	$0	$1,200	$1,400	$2,000	$2,200	$2,100	$2,300	$2,700	$2,500	$3,400
2.5% (avg SCC)	$0	$1,800	$2,100	$3,100	$3,300	$3,200	$3,500	$4,200	$3,800	$5,200
3% (95th percentile)	$0	$3,600	$4,300	$6,200	$6,600	$6,400	$7,100	$8,300	$7,600	$10,400
Monetized Net Benefits at each assumed SCC value [a, b]										
5% (avg SCC)	$0	$9,700	$11,600	$16,600	$17,000	$16,500	$18,600	n/a	$18,900	n/a
3% (avg SCC)	$0	$10,600	$12,600	$18,000	$18,600	$18,000	$20,200	n/a	$20,700	n/a
2.5% (avg SCC)	$0	$11,200	$13,300	$19,100	$19,700	$19,100	$21,400	n/a	$22,000	n/a
3% (95th percentile)	$0	$13,000	$15,500	$22,200	$23,000	$22,300	$25,000	n/a	$25,800	n/a

Notes:

[a] 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 (SCC 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.

[b] Section VIII.G notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $22-$46; for Average SCC at 2.5%: $36-$66; and for 95th percentile SCC at 3%: $66-$139. Section VIII.G also presents these SCC estimates.

[c] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this proposal (see RIA Chapter 5). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero.

[d] Non-GHG-related health and welfare impacts (related to $PM_{2.5}$ and ozone exposure) were not estimated for this proposal, but will be included in the analysis of the final rulemaking.

[e] "+c" indicates additional costs not estimated in this proposal.

Table IX-5: Monetized Net Benefits Associated with Each Alternative in 2050 (Million 2008 dollars)

	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5	Alt.6a	Alt.6	Alt.6b	Alt.7	Alt.8
Technology Costs [e]	$0	-$700	-$900	-$1,600	-$2,400	-$2,000	-$2,500	-$7,600 +c	-$3,700	-$59,000 +c
Fuel Savings (pre-tax)	$0	$17,900	$19,000	$29,500	$32,000	$30,600	$35,400	$41,500	$37,200	$55,200
Energy Security Impacts (price shock)	$0	$900	$1,000	$1,500	$1,700	$1,600	$1,800	$2,200	$1,900	$2,900
Accidents, Congestion, Noise	$0	-$300	-$300	-$500	-$500	-$500	-$600	-$700	-$600	-$900
Refueling Savings	$0	$120	$90	$180	$200	$190	$200	$270	$240	$410
Non-CO_2 GHG Impacts and Non-GHG Impacts [c,d]	$0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reduced CO_2 Emissions at each assumed SCC value [a, b]										
5% (avg SCC)	$0	$900	$900	$1,400	$1,600	$1,500	$1,700	$2,000	$1,800	$2,700
3% (avg SCC)	$0	$2,500	$2,700	$4,100	$4,500	$4,300	$4,900	$5,800	$5,200	$7,700
2.5% (avg SCC)	$0	$3,600	$3,900	$6,000	$6,500	$6,200	$7,100	$8,400	$7,500	$11,100
3% (95th percentile)	$0	$7,600	$8,100	$12,500	$13,600	$13,000	$14,800	$17,600	$15,800	$23,300
Monetized Net Benefits at each assumed SCC value [a, b]										
5% (avg SCC)	$0	$18,800	$19,800	$30,500	$32,600	$31,400	$36,000	n/a	$36,800	n/a
3% (avg SCC)	$0	$20,400	$21,600	$33,200	$35,500	$34,200	$39,200	n/a	$40,200	n/a
2.5% (avg SCC)	$0	$21,500	$22,800	$35,100	$37,500	$36,100	$41,500	n/a	$42,500	n/a
3% (95th percentile)	$0	$25,500	$27,000	$41,600	$44,600	$42,900	$49,300	n/a	$50,800	n/a

Notes:
[a] 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 (SCC 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.
[b] Section VIII.G notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $22-$46; for Average SCC at 2.5%: $36-$66; and for 95th percentile SCC at 3%: $66-$139. Section VIII.G also presents these SCC estimates.
[c] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this proposal (see RIA Chapter 5). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero.
[d] Non-GHG-related health and welfare impacts (related to $PM_{2.5}$ and ozone exposure) were not estimated for this proposal, but will be included in the analysis of the final rulemaking.
[e] "+c" indicates additional costs not estimated in this proposal.

C. How would the agencies include commercial trailers, as described in alternative 7?

A central theme throughout our proposed HD Program is the recognition of the diversity and complexity of the heavy-duty vehicle segment. Trailers are an important part of this segment and are no less diverse in the range of functions and applications they serve. They are the primary vehicle for moving freight in the United States. The type of freight varies from retail products to be sold in stores, to bulk goods such as stones, to industrial liquids such as chemicals, to equipment such as bulldozers. Semi-trailers come in a large variety of styles—box, refrigerated box, flatbed, tankers, bulk, dump, grain, and many others. The most common type of trailer is the box trailer, but even box trailers come in many different lengths ranging from 28 feet to 53 feet or greater, and in different widths, heights, depths, materials (wood, composites, and/or aluminum), construction (curtain side or hard side), axle configuration (sliding tandem or fixed tandem), and multiple other distinct features. NHTSA and EPA believe trailers impact the fuel consumption and CO_2 emissions from combination tractors and the agencies see opportunities for reductions. Unlike trucks and engines, EPA and NHTSA have very limited experience related to regulating trailers for fuel efficiency or emissions. Likewise, the trailer manufacturing industry has only the most limited experience complying with regulations related to emissions and none with regard to EPA or NHTSA certification and compliance procedures. We have therefore decided not to propose regulations for trailers in this proposal. However in order to broadly solicit comments on controlling fuel efficiency and GHG emissions through trailer regulations we are describing in an advanced notice of proposed regulation style a program which could set the foundation of a future rulemaking for trailers. We are soliciting comments on all aspects of the information shared in this section.

(1) Why are the agencies considering the regulation of trailers?

Trailers impact the aerodynamic drag, rolling resistance, and overall weight of the combination tractor-trailer. TIAX, LLC performed an evaluation of SmartWay trailer technologies, and found that they provide the opportunity to reduce fuel consumption and greenhouse gas emissions from tractor trailers by up to 10 to 12 percent for aerodynamics and 3 to 6 percent for lower rolling resistance tires.[434] Reductions of this magnitude are larger than can be readily accomplished from improvements in engine design and are roughly of the same magnitude as reductions possible through improvements in truck designs. Not only do trailers represent a significant opportunity for reductions as discussed later in this section, but we have strong reason to believe that these reductions would not occur absent regulation as noted in the recent NAS report.

The NAS report notes:

A perplexing problem for any option, regarding Class 8 vehicles, is what to do about the trailer. The trailer market represents a clear barrier with split incentives, where the owner of the trailer often does not incur fuel costs, and thus has no incentive to improve aerodynamics of the trailer itself or to improve the integration of the trailer with the tractor or truck.[435]

In other words, trailers affect the fuel efficiency of shipping, but they do not face strong uniform incentives to coordinate with truck owners. In principle, if truck owners had the ability to choose what trailers they accepted, they could require trailers with fuel-saving technologies; in practice, though, truck owners have limited practical ability to be selective about what trailers they accept.

In this setting, information provision may be inadequate to address the related problems of split incentives and thin markets. Regulation aimed at trailer manufacturers can contribute fuel savings and GHG reductions that otherwise may be difficult to achieve.

(2) What does the trailer industry look like?

(a) Trailer Types

The commercial trailer market includes a wide variety of trailer types. The market is dominated by box (or van) trailers, which made up approximately 63 percent of the new trailers registered between 2003 and 2007.[436] The top ten new trailer registrations are included by type are listed in Table IX–6.

Table IX-6: Trailer Registrations

Trailer Type	Percentage of Registrations (2003-2007)[437]
Box	63%
Flatbed (Platform)	8%
Container Chassis	7%
Refrigerated Van	5%
Dump	3%
Grain	2%
Flatbed Drop Deck	2%
Tank	1%
Lowbed	1%
Livestock	1%

The remaining 6.5percent of the trailer registrations consisted of livestock, transfer, hazardous chemical tanks, hoppers, gooseneck livestock, lowbed drop deck, beverage, special, dry bulk tanker, logging, wood chip, and other types of trailers. Within each of these main trailer categories there are distinctions among trailer construction, materials, dimension, mass, and functionality, all of which can impact a trailer's contribution to truck fuel consumption and greenhouse gas emissions.

(b) Trailer Fleet Size Relative to the Tractor Fleet

The industry generally recognizes that the ratio of the number of trailers in the fleet relative to the number of tractors is typically three-to-one.[438] Typically at any one time, two trailers are parked while one is being transported. For

[434] TIAX. Assessment of Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles. November 2009. Pages 4–50 and 4–57.

[435] *See* NAS Report, Note 111, above, at p. 8–8.

[436] *See* MJ Bradley, Note 431.

[437] *See*MJ Bradley, Note 431.

[438] *See* TIAX at Note 434 above, at p. 4–49.

certain private fleets, this ratio can be greater, as high as six-to-one. This characteristic of the fleet impacts the cost effectiveness of trailer technologies because a trailer on average will only travel one third of the miles travel ed by a tractor.

(c) Trailer Owners

Trailer ownership is distinct from that of the tractors. Trailers are often owned by shippers or by leasing companies, not by the trucking fleets. A special type of "trailer" is a shipping container used for intermodal surface movement to transport freight from ocean going liner vessels to inland destinations via truck, rail or barge. When hauled by a truck, the container is loaded on a specialty piece of equipment called a "chassis." This consists of a frame and axle/wheel assemblies on which the container is mounted, so that when the chassis and container are assembled the unit serves the same function as a road trailer (per 46 CFR 340.2). Container chassis are sometimes owned by specialty companies and are leased to ports, fleets, and shippers. Trailers that are purchased by fleets are typically kept much longer than are the tractors, so trucks and trailers have different purchasing cycles. Because of the disconnect between owners, the trailer owners may not benefit directly from fuel consumption and GHG emission reductions.

(d) Trailer Builders

The top ten builders with the largest market share of trailer sales in 2009 include Utility Trailer Manufacturing, Great Dane, Wabash National, Hyundai Translead, Timpte, Wilson Trailer, Stoughton Trailers, Heil Trailer, Fontaine Trailer, and MANAC.[439] However, nearly half of all trailer manufacturers are considered small businesses by the Small Business Administration definition.[440] Therefore, the agencies will be required to convene a Small Business Regulatory Enforcement Fairness Act (SBREFA) panel to conduct the proper outreach to all stakeholders impacted by a proposed regulation for trailers.

Although trailer manufacturing is an important sector within the commercial vehicle manufacturing industry, trailers are far less mechanically complex than are the trucks that haul them. This means that trailer manufacturing has a low barrier to entry compared to automotive or truck manufacturers. The agencies can envision that proposed regulation would require significant effort to maintain a level playing field within the market to reduce the incentive to work around the regulation.

(3) What technologies are available to reduce fuel consumption and GHG emissions from trailers?

There are opportunities to reduce the fuel consumption and GHG emissions impact of the trailer through aerodynamics, tires, and tare weight reductions to some extent in most types of trailers. In addition, refrigerated trailers have opportunities to both reduce the fuel consumption and CO_2 emissions of the transportation refrigeration unit and reduce GHG emissions through reduced refrigerant leakage. There are additional opportunities being developed for improvements in suspension systems, trailer structure, dump hoists and other features, depending upon the type of trailer and its intended function.

(a) Aerodynamics

Trailer aerodynamic technologies to date have focused on the box, van trailers—the largest segment of the trailer fleet. This focus on box, van trailers may also be partially attributed to the complexity of the shape of the non-box, van trailers which, in many cases, transport cargo that is in the windstream (*e.g.,* flatbeds that carry heavy equipment, car carriers, and loggers). For non-box, van trailers you could have a different aerodynamic shape with every load. While some technologies exist to address aerodynamic drag for non-box, van trailers, it has been either experimental or not widely commercially available.

Current trailer aerodynamic technologies for box trailers are estimated to provide approximately 10–12 percent reductions in drag when used as a package.[441] For box trailers, trailer aerodynamic technologies have addressed drag at the front of the trailer (*i.e.,* vortex traps, leading edge fairings), underneath the trailer (*i.e.,* side skirts, wheel fairings) and the trailer rear (*i.e.,* afterbodies). These technologies are commercially available and have seen moderate adoption rates. More recent trailer aerodynamic innovations channel air flow around the sides and under the trailer using underbody air deflectors ("underbelly treatment"). Table IX–7 lists technologies that the EPA SmartWay program has evaluated for use on box, van trailers. In general, the performance of these technologies is dependent upon the smooth transition of airflow from the tractor to the trailer. Overall shape can be optimized to minimize trailer aerodynamic drag, just as shape can reduce tractor aerodynamic drag.

[439] Trailer-Body Builders.com. 2009 North American Truck Trailer Output. Available at *http://trailer-bodybuilders.com/trailer-output/output/2009_trailer_output_table/.*

[440] Per SBA definition for NAICS 336212, companies with less than 500 employees are considered small businesses.

[441] *See* TIAX at Note 434, above, at 4–50.

Table IX-7: Aerodynamic Technologies for Trailers

Location on Trailer	Technology Type	Designed Effect
Front	Vortex trap	Reduce drag induced by cross-flow through gap between tractor and trailer
Front	Front fairings	Smoothly transition air to flow from tractor to the trailer
Rear	Afterbody (boat tail and rear fairings)	Reduce pressure drag induced by the trailer wake
Undercarriage	Side skirts	Manage flow of air underneath tractor to reduce eddies and wake
Undercarriage	Underbelly treatment	Manage flow of air underneath tractor to reduce eddies and wake
Accessories	General	Reducing surface area perpendicular to travel and minimizing complex shapes that may induce drag
General	Advanced, passive air management	Manage airflow through passive aerodynamic shapes or devices that keep flow attached to the vehicle (tractor and trailer)

The agencies' initial assessment of the incremental costs of aerodynamics is included in Table IX–8. The costs represent a high volume retail price of the components based on information developed for the NAS report [442] and the ICF cost contract.[443]

Table IX-8: Aerodynamic Technology Costs

Technology	Cost Estimate
Trailer Side Skirts	$1300 - 1600
Gap Fairing	$850
Trailer Aerocone	$1,000
Boat Tails	$1960
Air Tabs	$180

Some of these technologies, such as side skirts, may be applicable to other trailer types. The agencies are interested in comments regarding the aerodynamic improvement opportunities in all types of trailers.

(b) Tires

The rolling resistance coefficient baseline for today's fleet is 6.5 kg/ton for the trailer tire, based on sales weighting of the top three manufacturers based on market share. This value is based on new trailer tires, since rolling resistance decreases as the tread wears. To achieve the intended emissions benefit, SmartWay established the maximum allowable rolling resistance coefficient for the trailer tire 15% below the baseline or 5.5 kg/ton. Similar to combination tractor tires, LRR tires are available as either dual tires or as single wide-base tires for trailers.

Research indicates the contribution to overall vehicle fuel efficiency by tires is approximately equal to the proportion of the vehicle weight on them.[444] On a fully loaded typical Class 8 long-haul tractor and trailer, 42.5 percent of the total tire energy loss attributed to rolling resistance is from the trailer tires. The TIAX assessment of single wide based tires on the trailer found that they provide approximately a 3 percent fuel consumption benefit over a standard dual tire package.[445]

Based on the ICF report,[446] EPA and NHTSA estimate the incremental retail cost for LRR tires as $78 per tire. The agencies also estimate that the incremental cost to replace a pair of dual tires with a single wide based tire is $216, however, the cost can be reduced when the wheel replacement cost is considered, since half the number of tires and wheels are needed.

The inflation pressure of tires also impacts the rolling resistance.

[442] *See* TIAX, Note 434 above.

[443] ICF. Investigation of Costs for Strategies to Reduce Greenhouse Gas Emissions for Heavy-Duty On-Road Vehicles. July 2010. Page 96.

[444] Bridgestone Firestone, North American Tire, LLC. "Tires & Truck Fuel Economy," A New Perspective. Special Edition Four, 2008

[445] *See* TIAX, Note 434 above, at p. 4–56.

[446] *See* ICF, Note 443, above.

Underinflation causes an increase in rolling resistance and fuel consumption. Trailer systems, such as tire pressure monitoring or automatic tire inflation, can help drivers insure that they are traveling with properly inflated tires. Estimates vary, but TIAX estimates on average that a trailer automatic tire inflation system could provide a 0.6% benefit to fuel consumption for a cost of approximately $300 to $400.[447]

(c) Weight Reduction

Reduction in trailer tare (or empty) weight can lead to fuel efficiency reductions in two ways. For applications which are not limited by the weight limit, the overall weight of the tractor and trailer combination would be reduced and would lead to improved fuel efficiency. For the applications which limit the payload due to the weight restrictions, the lower trailer weight would allow additional payload to be transported during the truck's trip. Weight reduction opportunities in trailers exist in both the structural components and in the wheels and tires. Material substitution (replacing steel with aluminum) is feasible for components such as roof posts, bows, side posts, cross members, floor joists, and floors. Similar material substitution is feasible for wheels. Weight reduction opportunities also exist through the use of single wide based tires replacing two dual tires.

The agencies' assessment of the ICF report[448] indicates that the expected incremental retail prices of the lightweighted components are as included in Table IX–9: Trailer Lightweighting Costs.

Table IX-9: Trailer Lightweighting Costs

Component	Cost
Roof Posts/Bows	$120
Side Posts	$525
Cross Members/Floor Joists	$400
Floor	$1,500
Wheels	$1,500

(d) Opportunities in Refrigerated Trailers

Refrigeration units are used in van trailers to transport temperature sensitive products. A traditional transportation refrigeration unit is powered by a nonroad diesel engine. There are GHG reduction opportunities in refrigerated trailers through the use of electrical trailer refrigeration units and highly reflective trailer coatings.

Highly reflective materials, such as reflective paints or translucent white fiberglass roofs, can reflect the solar radiation and decrease the cooling demands on the trailer's refrigeration unit. A reflective composite roof can cost approximately $800, the addition of reflective tape to a trailer roof would cost approximately $450.

Hybrid trailer refrigeration units utilize a diesel engine which drives a generator which in turn powers the compressor and fans. The cost of this unit is approximately $4,000.

(4) What approaches could the agencies propose for evaluating fuel efficiency and GHG emissions contributions from trailers?

Building from EPA's SmartWay experience, EPA and NHTSA have considered several options to demonstrate GHG and fuel consumption reductions from trailer technologies. The agencies welcome comments on the testing approaches describe below or alternative recommendations.

(a) Metric

There are several metrics that the agencies envision could be appropriate used to evaluate the fuel consumption and CO_2 emissions due to trailers. The agencies are proposing the use of a ton-mile metric with a prescribed payload for the vocational vehicle and tractor regulatory categories and subcategories. A similar approach could be applied to trailer evaluation, which would account for aerodynamic improvements, tire improvements, and trailer lightweighting. However, a ton-mile metric does not necessarily capture the capacity aspect of trailers. Box trailers provide benefits to freight efficiency through an increase in either cubic volume or pallet-equivalent. Certain box van trailers including drop frame moving van trailers and high cube trailers are specially designed to maximize cubic capacity. The agencies welcome comments regarding the appropriate metric for trailer efficiency demonstration.

(b) Potential Approaches to Evaluate GHG Emissions and Fuel Consumption Reducing Technologies

(i) Design-Based Specification Approach

The SmartWay certification for tractors and dry box van trailers began as a design-based specification, developed on the basis of test results for APUs, and engines that have been demonstrated to improve fuel efficiency and reduce emissions.

(ii) Modeling Approach

As the agencies are proposing for the evaluation of tractors and vocational vehicles, a similar simulation model approach could also be applied to trailers. A simulation-based model would require the trailer manufacturer input parameters similar to the ones proposed in the tractor program—coefficient of drag, tire rolling resistance, and weight. The agencies envision that a standardized tractor would be required to fairly assess the tractor-trailer system. Both agencies have years of successful experience with vehicle simulation modeling. EPA, DOE, DOT, Commerce and others used vehicle simulation modeling to jumpstart technology scenarios for the Partnership for a New Generation of Vehicles Program, a large public-private research program aimed at developing advanced fuel-efficient passenger vehicle designs. Those same agencies used vehicle simulation modeling for a similar purpose in the 21st Century Truck Partnership, a sister program to develop advanced fuel-efficient commercial truck designs. EPA used vehicle simulation modeling to characterize various technology scenarios for its initial design of the

[447] See TIAX, Note 434 above, at p. 4–58.

[448] *See* ICF, Note 443, above.

SmartWay program and to conduct analyses on its test data, test cycles, and related data. This experience has demonstrated to the technical staff at EPA and DOT that vehicle simulation modeling can be a reliable and feasible tool to assess vehicle performance. EPA and NHSTA welcome comments from trailer manufacturers on their ability to run simulation models and evaluate the aerodynamics of the trailers which they produce.

(iii) Whole Vehicle Testing—Chassis, Track or On-Road Test

Complete vehicle testing is commonly conducted on chassis dynamometers, tracks, or on the road. Light-duty vehicles are tested on chassis dynamometers to demonstrate compliance with EPA and NHTSA regulations associated with emissions and fuel efficiency, respectively. Heavy-duty truck manufacturers often use paired truck test, such as prescribed in SAE J1321,[449] to evaluate the difference between two trucks. The current SmartWay verification program allows for a modified SAE J1321 test to be used to evaluate the fuel consumption performance of trailers due to improvements in aerodynamic design. Heavy-duty truck fleets today commonly use long term on-road testing to evaluate trucks, trailers, and technologies.

A chassis dynamometer test is a test conducted indoors on a hydrokinetic chassis dynamometer. The chassis dynamometer option in this test procedure incorporates many of the methods and requirements established in the Federal light-duty vehicle and 'light' heavy-duty vehicle emissions certification chassis test procedure. Chassis dynamometers may be found at vehicle test laboratories; typically, facilities used for emissions and vehicle fuel efficiency testing. Because the test is conducted on a chassis dynamometer, rolling resistance, aerodynamic drag and inertial road load power requirements must be determined ahead of time, with coastdown tests and calculations to determine the proper horsepower absorption setting for the chassis dynamometer.

A track test is a complete vehicle test conducted on an outside test track. Test tracks may be found at vehicle proving grounds or other facilities specifically designed for vehicle or tire performance testing. Because the test involves the vehicle being operated on a road surface in a manner similar to that of on-road driving, rolling resistance, aerodynamic drag, and inertial road load power requirements are incorporated in the test measurement, and do not have to be determined beforehand with a coastdown test and calculations. Although the result of a track test reflects real-world vehicle performance better than a chassis dynamometer test, by directly evaluating the impacts of road effects such as aerodynamic drag of tractors and trailers and rolling resistance effects of tires, variability of ambient conditions may result in greater variability of test results.[450] Therefore, any protocol should include specification of ambient conditions as well as specifications for measurement of fuel consumption.

The TMC/SAE Fuel Consumption test is a standardized on-road test procedure for comparing the in-service fuel consumption of two conditions of a test vehicle or one test vehicle to another.[451] The procedure uses an unchanging control vehicle run in tandem with the test vehicle. The result of the test is the percent difference in fuel consumption between two test vehicles.

The agencies are interested in comments regarding the advantages and disadvantages of each approach, along with any baseline trailer performance.

(5) What actions are already being taken to improve the efficiency of trailers?

(a) SmartWay Certified Trailers

Beginning in 2007, EPA began designating certain new dry freight box van trailers for on the road use of 53 feet or greater length Certified SmartWay Trailers. Older or pre-owned trailers could also be certified if properly retrofitted. In order for a trailer to be designated as Certified SmartWay, the trailer must be equipped with aerodynamic devices such as trailer skirts and gap reducers along with verified LRR trailer tires (either dual or single-wide). Trailer manufacturers can also test trailers using a modified J1321 test method to assess the fuel-saving impact of the aerodynamic features. Trailers that meet or exceed the minimum threshold for reduction in fuel consumption and that are equipped with SmartWay-verified LRR tires are eligible for SmartWay designation. Information about SmartWay certified trailers, the test methods, and verified trailer equipment is at the U.S. EPA SmartWay Web site, *http://www.epa.gov/smartway*.

(b) California AB32

The California requirement to reduce GHG emissions from trailers became effective in 2010.[452] It requires that all new 2011 model year dry van trailers are SmartWay certified or demonstrate a 5 percent aerodynamic and a 1.5 percent tire improvement. Compliance is demonstrated through the use of SmartWay certified components or a SAE paired-truck test to demonstrate improvements. California is also requiring retrofit of existing van trailers phasing in starting in 2011. Information on the California program can be found at the California Air Resources Board Web site, *http://www.arb.ca.gov/cc/hdghg/hdghg.htm*.

(6) Why are the agencies delaying regulation and what are the next steps for trailer regulation?

It is the intent of both agencies to take advantage of available and very near-term technologies to achieve early reductions in greenhouse gas emissions and fuel consumption. As noted above, President Obama requested both agencies to coordinate to create a first-ever National Policy to increase fuel efficiency and decrease greenhouse gas pollution from medium- and heavy-duty trucks for model years 2014–2018. To meet the goals within the time frame outlined by the President in his directive, EPA and DOT are moving expeditiously to develop these proposed regulations as outlined in this proposal.

The expertise of each agency's technical and regulatory staff, along with critical input from the SmartWay program, industry and other key stakeholders, make it feasible to propose regulations covering commercial heavy-duty trucks within this time frame. However, both EPA and NHTSA recognize, along with the NAS, the diversity and complexity of the trailer industry. There are dozens of trailer types, dozens of trailer manufacturing entities, and several diverse trailer end user groups. In addition to the challenge of addressing these multiple complexities, unlike many other vehicle sectors, this is an industry that has never before been subject to either emissions or fuel economy regulation.

Additionally, since a number of trailer manufacturing entities are small businesses, EPA and NHTSA need to allow sufficient time to convene a

[449] Society of Automotive Engineers. Joint TMC/SAE Fuel Consumption Test Procedure—Type II. SAE J1321. October 1986.

[450] However, it has been demonstrated that even tests conducted in laboratories have differences in repeatability within a given laboratory and differences in reproducibility among laboratories. See "Interlaboratory Crosscheck of Heavy-duty Vehicle Chassis Dynamometers" Final Report Coordinating Researth Council Project No. E–55–1, May 2002.

[451] See SAE, Note 449, above.

[452] California Air Resources Board. Available at *http://www.arb.ca.gov/regact/2008/ghghdv08/ghghdv08.htm*, accessed September 17, 2010.

SBREFA panel to conduct the proper outreach to the potentially impacted stakeholders.

Therefore, EPA and NHTSA propose to follow their proposals for heavy-duty truck regulations with a proposal for regulating trailers, at a future date to be determined after both agencies conduct a more comprehensive assessment of the topics discussed in this section. EPA and NHTSA welcome comment on delaying proposing trailer regulations and on related topics that might affect the timing of such a proposal.

X. Recommendations From the 2010 NAS Report

A. Overview

One of the most important resources for the agencies in developing the HD National Program was the report produced by the National Academy of Sciences in response to Congress' mandate in EISA. Section 108 of EISA states that DOT (by delegation, NHTSA) must execute an agreement with the NAS "to develop a report evaluating MD/HD truck fuel economy standards, including:

(1) An assessment of technologies and costs to evaluate fuel economy for MD/HD trucks;

(2) An analysis of existing and potential technologies that may be used practically to improve MD/HD truck fuel economy;

(3) An analysis of how such technologies may be practically integrated into the MD/HD truck manufacturing process;

(4) An assessment of how such technologies may be used to meet fuel economy standards to be prescribed under 49 U.S.C. 32902(k); and

(5) Associated costs and other impacts on the operation of MD/HD trucks, including congestion.

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. NAS requested and was granted an additional six months to complete its report, so based on the date of execution of the ultimate agreement, the deadline for the NAS report was determined to be March 2010.

The NRC Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles was formed to fulfill the contract between NHTSA and the NAS.[453] Interpreting the tasks listed in Section 108 of EISA, NAS directed the committee to:

- Consider approaches to measuring fuel economy for medium- and heavy-duty vehicles that would be required for setting standards;
- Assess current and potential technologies and estimate improvements in fuel economy for medium-duty and heavy-duty trucks that might be achieved;
- Address how the technologies identified in the task above may be used practically to improve medium-duty and heavy-duty truck fuel economy;
- Address how such technologies may be practically integrated into the medium-duty and heavy-duty truck manufacturing process;
- Assess how such technologies may be used to meet fuel economy standards;
- Discuss the pros and cons of approaches to improving the fuel efficiency of moving goods as opposed to setting vehicle fuel economy standards; and
- Identify the potential costs and other impacts on the operation of medium-duty and heavy-duty trucks.[454]

The final publication of the NAS Report "Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles" (the "NAS Report") was made available to the public in September 2010.[455] Although the NAS Report was developed and written in terms of reducing fuel consumption, its findings and recommendations apply equally to a program that reduces GHG emissions, given the close relationship between the two.

B. What were the major findings and recommendations of the 2010 NAS Report, and how is the proposed HD National Program consistent with them?

The 2010 NAS Report spanned eight chapters and several hundred pages, with dozens of major findings and recommendations. While this preamble refers frequently throughout to the various NAS findings and recommendations as it explains the HD National Program, this particular section is designed to provide the reader with a quick reference guide to the findings and recommendations and the extent to which the agencies' proposed program is consistent with them. The significant majority of NAS' findings and recommendations have been implemented directly by the agencies. Generally speaking, to the extent that the proposed HD National Program diverges from the NAS recommendations, it is often due to differences in the agencies' approach as compared to NAS' expectations for a HD regulatory program, which the agencies think are necessary and beneficial in order to obtain the greatest GHG and fuel consumption reductions as rapidly as possible, and to facilitate the transition for the industry to a more holistic regulatory system over a longer timeframe.

Instead of discussing the NAS Report findings and recommendations in the order presented in the Report itself, as is done in the NHTSA Study accompanying this NPRM, this section divides the NAS findings and recommendations into three categories: findings and recommendations with which (1) the HD National Program is consistent; (2) the HD National Program is significantly inconsistent; and (3) the HD National Program is less-significantly inconsistent.

(1) NAS Findings and Recommendations With Which the Proposed HD National Program Is Consistent

(a) What metrics should be employed for regulating fuel consumption/GHG emissions?

With the light-duty fuel economy and GHG regulations as a backdrop, the NAS committee considered the difference between fuel *economy* (a measure of how far a vehicle will go on a gallon of fuel) and fuel *consumption* (the inverse measure, of how much fuel is consumed in driving a given distance) as potential metrics for MD/HD regulations.[456] Noting the non-linear nature of fuel economy—*e.g.,* that more fuel can be saved by increasing fuel economy from 14 to 16 mpg than from 30 to 32 mpg—and its potential to confuse consumers, the committee concluded that fuel economy would not be a good metric for judging the fuel efficiency of a vehicle, and stated that it would use fuel *consumption* throughout the report instead.[457]

However, because MD/HD vehicles are designed to carry loads in an efficient and timely manner, as opposed to light-duty vehicles which are generally used simply for carrying passengers, the committee suggested

[453] 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, 2010).

[454] *See* Note 453 above, at 10.

[455] *Id.*

[456] *See* Note 453 above, at 20 through 25.

[457] *Id.* at 24.

that normalizing the fuel consumption to the payload that the vehicle hauls would be the best way to represent an appropriate attribute-based fuel consumption metric.[458] The committee identified this metric as Load-Specific Fuel Consumption (LSFC), defined as fuel consumption on a given cycle (in gallons/100 miles), divided by payload (in tons).[459] The committee thus recommended that any HD fuel consumption regulation use LSFC as the metric and be based on using an average (or typical) payload based on national data representative of the classes and duty cycle of the vehicle.[460] The committee noted that standards might require different values of LSFC due to the various functions of the vehicle classes, *e.g.,* pickup trucks versus utility trucks versus line-haul trucks.[461] The committee stated that any data reporting or labeling should state an LSFC at specified tons of payload.[462]

The agencies agree that the appropriate metric for regulating HD vehicle GHG emissions and fuel consumption is one tied to the vehicle's task and reflects the work done by the vehicle. Thus, the agencies have employed different metrics in developing the proposed standards in this NPRM, as follows:

The metric for HD engines is grams of CO_2 per brake horsepower-hour and gal/100 bhp-hr, which normalizes CO_2 emissions and fuel consumption based on work done.

The metric for Class 7 and 8 combination tractors is grams of CO_2 per ton-mile and gal/1,000 ton-mile, which normalizes CO_2 emissions and fuel consumption based on the work done in transporting payload.

The metric for vocational vehicles is also grams of CO_2 per ton-mile and gal/1,000 ton-mile, which normalizes CO_2 emissions and fuel consumption based on work done.

The metric for HD pickup trucks and vans is grams of CO_2 per mile and gal/100 mi. While these metrics are not normalized by payload, standards are based on the work done by the vehicles in that the standards are vehicle attribute based and a function of payload capacity and towing capacity (and whether two-wheel drive or four-wheel drive).

In establishing measurement driving cycles and vehicle load settings, the agencies carefully review reviewed available data and selected cycles and vehicle load settings that are judged to be most representative of national average use.

Thus, as NAS recommended, the agencies are proposing separate standards with different metrics—all based on consideration of the tasks vehicles perform and the work they do, which is consistent with the LSFC concept—for different categories of vehicles.

The agencies have no plan to require fuel consumption labeling, or to publish values for individual vehicles. Because of the broad range of actual vehicle use, including the range of payloads carried, driving cycles and road terrain, and recognizing that, for individual vehicles, engines, transmission ratios, final drive ratios and tire sizes are selected based on intended use, the agencies judge that a label or published fuel consumption value, based on testing under average conditions, would likely not provide an accurate assessment of individual vehicle fuel consumption performance, and may be misleading.

(b) Which Classes of Vehicles Should be Regulated?

The committee stated that while it may seem expedient to initially focus on those classes of vehicles with the largest fuel consumption (*i.e.,* Class 8, Class 6, and Class 2b, which together account for approximately 90 percent of fuel consumption of HD vehicles), the committee believes that selectively regulating only certain vehicle classes would lead to very serious unintended consequences and would compromise the intent of the regulation.[463] The committee suggested, however, that within vehicle classes, there may be certain subclasses of vehicles (*e.g.,* fire trucks) that could be exempt from the regulation without creating market distortions.[464]

The agencies agree that it is crucial to avoid unintended consequences such as class shifting, which might occur as a result of regulating only certain classes of trucks. Thus, as NAS recommended, the agencies are regulating all Classes 2b through 8 in this first round of regulations, with different standards tailored to different groups of vehicles to maximize fuel savings and emissions reductions as appropriate for the work that they perform. In addition, the agencies agree with the NAS recommendation that certain subclasses be exempted from regulation and have provided flexibilities that include Averaging, Banking and Trading, and exemptions for some off-road vehicles.

Related to this recommendation, NAS also noted that large vehicle manufacturers with significant engineering capability design and manufacture almost all Class 2b, 3, and 8b vehicles, while small companies with limited engineering resources make a significant percentage of vehicles in Classes 4 through 8a, although in many cases they buy the complete chassis from larger vehicle manufacturers.[465] The committee emphasized that regulators will need to take into account the limitations of these smaller companies.[466]

The agencies agree that the impacts on small manufacturers in Classes 4 through 8a should be considered in developing HD regulations, and have done so through the structure of our standards for those vehicle categories. *See* Section II in this preamble for a fuller discussion. The agencies are proposing to not set standards at this time for engine, chassis, and vehicle manufacturers which meet the small business definitions.

(c) What Test Procedures Should be Employed for Evaluating Compliance With Standards?

The committee emphasized that a certification test method must be highly accurate, repeatable, and identical to the in-use compliance tests, as is the case with current regulation of light-duty vehicles tested on a chassis dynamometer, and for heavy-duty engine emission standards tested on engine dynamometers.[467] The committee stated that using the process and results from existing engine dynamometer testing for criteria emissions to certify fuel economy standards for MD/HD vehicles would build on proven, accurate, and repeatable methods, and put less additional administrative burden on the industry.[468] However, the committee cautioned that to account for the fuel consumption benefits of hybrid powertrains and transmission technology, the present engine-only tests for emissions certification will need to be augmented with other powertrain components added to the engine test cell, either as real hardware or as simulated components.[469] Additionally, the vehicle attributes (aero, tires, mass) would need to be accounted for, perhaps by using vehicle-specific prescribed loads (via models) in the test cycle, which the committee

[458] *See* Note 453 above, at 25, and at 189, Recommendation 8–3.

[459] *Id.*

[460] *See* Note 453 above, at 39, Recommendation 2–1.

[461] *Id.* The committee also stated that regulators should use a common procedure to develop baseline LSFC data for various applications, to determine if separate standards are required for different vehicles that have a common function.

[462] *Id.*

[463] *Id.* at 189, Finding 8–1.

[464] *See* Note 453 above.

[465] *Id.,* Finding 8–2.

[466] *Id.*

[467] *Id.* at 190, Finding 8–8.

[468] *Id.,* Finding 8–9.

[469] *See* Note 453 above.

stated would require close cooperation among component manufacturers and vehicle manufacturers.[470]

The committee noted that since there is currently no established Federal test method for HD vehicle fuel consumption, either empirical testing (whether at the component level or up to the whole vehicle level) or simulation modeling or both could be used for the characterization and certification of regulated equipment.[471] The committee cautioned that each approach involves uncertainties that can affect certification and compliance, and stressed the need for a pilot regulation program to examine the potential for these effects.[472]

The committee also noted that significant segments of the MD/HD vehicle purchasing process are highly consumer-driven, with many engine, transmission, and drive axle choice combinations resulting in a wide array of completed vehicles for a given vehicle model.[473] The committee stressed that from a regulatory standpoint, the use of expensive and time-consuming chassis testing on each distinct vehicle variation is impractical.[474] However, the committee suggested that by knowing the performance of major subcomponents on fuel consumption, it may be practical to demonstrate compliance certification with vehicle standards by aggregating the subcomponents into a specified virtual vehicle for computers to evaluate fuel consumption of the completed vehicle.[475]

The committee stated that further research will be required to underpin the protocol used to measure key input parameters, such as tire rolling resistance and aerodynamic drag forces, and to ensure the robustness of simulations for evaluating vehicle fuel consumption.[476] However, the committee stated, once determined, these major components may be assembled through simulation to represent a whole-vehicle system, and models benchmarked to reliable data may be used to extend the prediction to a variety of vehicle types, by changing bodies (aerodynamic measures), tires, and operating weights associated with the powertrains.[477]

Thus, the committee recommended that the agency consider the use of simulation modeling with component test data and additional tested inputs from powertrain tests as a way of lowering cost and administrative burdens yet achieving needed accuracy of results.[478] The committee stated that this is similar to the approach taken in Japan, but different in that the program would represent all of the parameters of the vehicle (powertrain, aerodynamics, and tires) and relate fuel consumption to the vehicle task.[479] The committee further recommended that the combined vehicle simulation/component testing approach be supplemented with tests of complete vehicles for audit purposes.[480]

The agencies agree that choosing accurate and repeatable test procedures that build on existing procedures to the maximum extent will minimize administrative burden and be crucial for the success of the program. Thus, as NAS recommended, the agencies are proposing chassis dynamometer testing for HD pickup trucks and vans, building off existing criteria pollutant emissions test programs and manufacturers' experience with light-duty fuel economy test procedures; engine dynamometer testing for HD engines, building off existing criteria pollutant emissions test programs; and vehicle simulation testing for vocational vehicles and Class 7–8 combination tractors, which is new for this program but which, the agencies believe, minimizes burden while maximizing accuracy and repeatability. The agencies have carefully considered measurement protocols for key simulation input parameters and have structured the program to reduce sensitivity to accuracy and repeatability issues. *See* Section V in this preamble for a fuller discussion. The agencies recognize the importance of continuing work to standardize and refine measurement methods and intend to work with industry and technical organizations to improve those measurement methods. The simulation program includes inputs for all vehicle parameters that affect fuel consumption, but the interface allows manufacturers to enter a limited number of the inputs for this first program. The majority of inputs have been preselected by the agencies to represent typical vehicle attributes in each regulatory category. The agencies believe this approach and the choice of preselected parameters will reduce the potential for unintended consequences. The simulation program also uses vehicle loads and driving cycles that were selected based on careful consideration of vehicle task, as recommended. And finally, testing of complete vehicles for audit purposes has occurred and will continue to occur during the comment period, in order to further hone the accuracy of the simulation approach. The agencies are thus consistent with NAS' recommendations with respect to test procedures.

The agencies have structured the program to regulate large manufacturers, and as such there are fewer regulated entities than the NAS study envisioned. The agencies agree with the NAS expectation that a program would require close cooperation among component manufacturers and vehicle manufacturers. The agencies believe the regulated manufacturers, and their suppliers, have sufficient resources to handle this burden, and in most cases are already operating with close cooperation.

(d) How should appropriate technologies be determined?

The committee emphasized that technology effectiveness (that is, its fuel consumption/emissions reduction potential) is extremely dependent on application (for example, a hybrid powertrain applied to a pickup truck versus line-haul tractor) and drive cycle (for example, start-stop versus steady-state, variations in load, *etc.*).[481] The committee also stressed that while some technologies are economically viable now, others may require significantly higher fuel costs or valuations of environmental/security externalities to make them cost-beneficial.[482]

The agencies recognize and agree that not all technologies are applicable in the same way to all HD trucks and all drive cycles, and that not all technologies are cost-beneficial in the timeframe of this rulemaking. The agencies divided the overall HD fleet into unique categories in order to group generally similar vehicle types that have generally similar uses. For vocational vehicles, where uses and drive cycles are highly varied, the agencies have structured the program in a way that should provide benefits broadly through the separate regulation of engines and the vehicle (effectively only the tires, for this first rulemaking). Measurement of fuel consumption performance in each category is based on estimated average drive cycles and vehicle loading for that category. Section III discusses these issues in considerable detail.

[470] *Id.*

[471] *Id.,* Finding 8–10.

[472] *Id.*

[473] *Id.,* Finding 8–11.

[474] *See* Note 453 above.

[475] *Id.*

[476] *Id.,* Finding 8–12.

[477] *Id.*

[478] *Id.,* Recommendation 8–4.

[479] *See* Note 453 above.

[480] *Id.*

[481] *Id.* at 5, Finding 4/5/6–1.

[482] *Id.,* Finding 4/5/6–2.

(2) NAS Findings and Recommendations With Which the Proposed HD National Program Is Not Significantly Consistent, and Why the Agencies Have Chosen a Different Path

(a) Should the Agencies Conduct a Pilot Program?

In briefings to the agencies following the completion of the NAS Report, the committee repeatedly stressed its final recommendation over all others: That NHTSA should conduct a pilot program before beginning to regulate HD fuel consumption officially, and that the pilot program should have these elements:

• NHTSA should "Gain experience with certification testing, data gathering, compiling and reporting. There needs to be a concerted effort to determine the accuracy and repeatability of all the test methods and simulation strategies that will be used with any proposed regulatory standards and a willingness to fix issues that are found."

• NHTSA should "Gather data on fuel consumption from several representative fleets of vehicles. This should continue to provide a real-world check on the effectiveness of the regulatory design on the fuel consumption of trucking fleets in various parts of the marketplace and various regions of the country."

The committee's fundamental concern was that given that HD fuel consumption had never previously been regulated, and given the scope of the regulatory system that the committee had envisioned, serious unintended consequences could occur if NHTSA did not build in extra time to conduct a pilot program, with negative effects on the regulated industry and on fuel savings.

With regard to NAS' first concern, that NHTSA must gain experience with certification testing, data gathering, compiling and reporting before initiating a HD fuel consumption regulatory system, the agencies believe that the proposed HD National Program may avoid the risks that NAS identified because it is based in large part on existing test protocols and reporting systems. The agencies' proposed certification and compliance programs for HD pickup trucks and vans, for example, employ the same testing procedures and reporting systems as for light-duty CAFE and GHG regulations, so both the agencies and the manufacturers who are regulated already have much experience with testing, data collection, and reporting.[483] For HD engine standard certification and compliance, similarly, the agencies' proposed systems rely on engine testing identical to that already used by EPA and manufacturers for criteria pollutant emissions regulations, and also vehicle modeling.

While it is true that the vehicle testing for Class 7–8 tractors and for vocational vehicles is new, the agencies believe that the proposed modeling approach will likely avoid NAS' concerns due to its degree of simplification, relative to what NAS considered. The agencies are not requiring the same level of whole vehicle simulation for certification and compliance as envisioned by NAS—instead, while manufacturers will take real-world measurements for each component or system attribute, those measurements will all be placed into "bins," and the bin value (which will be representative and pre-defined) will be the value actually employed in the modeling system. The agencies believe that this approach has considerable merit in the timeframe of this rulemaking to initiate the HD National Program for several reasons. First, since not all test methodologies have been firmly established, pre-defined bin values help to mitigate measurement uncertainty that might otherwise allow manufacturers to game the testing protocol. While there may be some loss of accuracy due to use of bin values rather than direct measurement values, and while the agencies will have to track vehicle model inputs carefully to ensure that manufacturers are not gaming the bins themselves, the agencies believe that the proposed levels of stringency should compensate for these risks. And second, waiting for a pilot program to gain additional experience with testing, data gathering, and reporting would delay our ability to get highly cost-effective fuel efficiency and emissions improvements, based on utilization of existing technologies, as soon as possible. If a pilot program were initiated as early as MY 2014, and it took one year to collect information to inform rulemaking and an additional year for finalizing a rule which, by statute, would provide 4 years lead time, the first regulated model year would be 2020. The costs of waiting to regulate officially, in terms of fuel savings and emissions reductions, would likely outweigh the potential benefits of gaining more experience, especially given the structure of the first phase of the proposed HD National Program.

With regard to NAS' second concern, that NHTSA must gather data on fuel consumption from representative fleets as a real-world check on the effectiveness of the regulatory design, the agencies believe that the proposed HD National Program will be much better able to avoid unintended consequences than the regulatory system that NAS envisioned because we do *not* propose to regulate the entire vehicle as a single system. The agencies believe that the proposed HD National Program approach has considerable merit for the timeframe of this rulemaking because it does not regulate transmission and final drive ratios and tire sizes, and thus allows manufacturers and customers to continue to specify these attributes in order to optimize them for specific vehicle use. This reduces the need for our regulatory program to define the real-world drive cycle (in terms of speed, load, grade, and altitude) exactly correctly for every individual vehicle, as envisioned by NAS. Additionally, by expressly requiring improvements in engine efficiency, the proposed HD National Program will require all vehicles to become more efficient regardless of their intended use. Although the agencies will not document exact real-world measured improvements in fuel efficiency/emissions reductions, the program will achieve percentage improvements that may be approximately estimated. Furthermore, while program benefits may be lower than the full potential envisioned by NAS if fleets choose to optimize powertrain specifications for purposes other than fuel efficiency, the agencies believe that achieving improvements sooner outweighs the less-certain later benefits of undertaking an initial pilot program as suggested by NAS.

(b) Should the agencies regulate trailers in the first phase of the HD National program?

The NAS committee recommended that NHTSA include trailers in its regulatory program to achieve maximum possible fuel efficiency improvements, and also to provide an incentive to manufacturers to optimize the tractor/trailer interface.[484] The committee noted that commercial trailers are produced by a separate group of about 12 major manufacturers that are not associated with truck manufacturers.[485] The committee stated that trailers represent an important opportunity for fuel consumption reduction, and can benefit from improvements in aerodynamics and tires.[486]

[483] *See* Section II of this preamble.

[484] *See* Note 453 above, at 189, Recommendation 8–2.

[485] *Id.*, Finding 8–3.

[486] *Id.*

For purposes of the proposed HD National Program, the agencies intend to consider regulation of trailers in a subsequent rulemaking and not in this initial phase. As the committee suggested, regulating trailers is very challenging due to the nature of the trailer industry, with many small manufacturers and very long vehicle lifespans. However, since trailer production volume is low, the agencies project that their impact on fuel consumption and emissions reduction will be much smaller than for regulating engines and tractors, as the agencies intend to do in the first phase of the HD National Program. The agencies are thus deferring trailer regulations until a subsequent phase.[487]

(c) Should the agencies include in their baseline analysis the effect of the California air resources board SmartWay mandate?

The committee found that the legislation passed by California requiring tractor-trailer combinations to be SmartWay certified will have a significant impact on the number of vehicles in the United States that are specified with fuel-efficient technologies beginning in 2010.[488] The agencies are using a 2010 baseline with an estimate of national sales mix that includes the sales of SmartWay tractors. The California trailer mandate is not reflected in either the baseline or the proposal estimates because this proposal does not regulate trailers. Therefore the agencies believe the estimated program for this proposal account for the effects of the California SmartWay mandate

(d) Should the agencies' aerodynamic drag test method include varying yaw angles?

The committee recommended that a HD fuel consumption regulation should require that aerodynamic features be evaluated on a wind-averaged basis that takes into account the effects of yaw, and that tractor and trailer manufacturers should be required to certify their drag coefficient results using a common industry standard.[489] The committee stated that yaw-induced drag can be accurately measured only in a wind tunnel.[490]

The agencies are not implementing this recommendation in the first phase of the proposed HD National Program. The current lack of common wind tunnel facilities precludes using a single aerodynamic test method at the outset of the program, which will begin with EPA's GHG regulations in 2014. Instead, the program will allow manufacturers to continue to use whatever aerodynamic test method they currently use. This will ease administrative burden, but the agencies recognize that it will create variability in measured aerodynamic values. To address this, the agencies are employing a bin system for aerodynamic drag values, and varying values will be grouped in the same bin.[491] The agencies anticipate investigating varying yaw angles in a subsequent rulemaking for a future phase of the HD National Program.

(e) Should the agencies complete an economic/payback analysis prior to beginning to regulate, in order to avoid unintended consequences?

The committee recommended that NHTSA's study (which it expected would precede the NPRM) include a careful economic/payback analysis based on fuel usage by application and different fuel price scenarios, including operating and maintenance costs.[492] The committee stated that standards that differentially affect the capital and operating costs of different vehicle classes can cause purchase of vehicles that are not optimized for particular operating conditions, and cautioned that the complexity of truck use and the variability of duty cycles increase the probability of these unintended consequences.[493]

The agencies have included in this NPRM and in the draft RIA a draft economic/payback analysis based on industry average operating cycles and expectations for ongoing maintenance costs. The agencies seek comment on the assumptions and analysis presented in Section VIII of the preamble and Chapter 9 of the draft RIA. In particular, the agencies request comment on the ability of these average assumptions to reflect payback periods for the industry as a whole and what if any changes the agencies should make in the analyses for the final rulemaking consistent with the recommendations of the NAS.

(f) How should the agencies account for indirect effects and unintended consequences as a result of the proposed HD National Program?

The committee stressed the need of regulators to consider a number of effects in the development of any proposals to regulate HD fuel consumption,[494] specifically fleet turnover impacts and pre-buy effects;[495] the rebound effect;[496] vehicle class shifting effects;[497] environmental co-benefits and costs;[498] congestion;[499] safety;a [500] and incremental weight impacts.[501] While the committee did not examine any of these effects in depth, it stated that it believed that a rebound effect likely exists, and that estimates of fuel savings from regulatory standards will be somewhat misestimated if the rebound effect is not considered.[502]

In response, while the agencies have initiated analyses of these unintended consequences, they have not all been completed in time to be incorporated into this NPRM. The NAS committee itself noted the lack of available information on these effects, especially as compared to the wealth of information available for light-duty fuel economy and GHG regulatory analysis. Much of this work must simply be done from scratch. The agencies have included estimates of the rebound effect in this NPRM and draft RIA,[503] but we hope to have analyses of other effects available for the final rule.

(3) NAS Findings and Recommendations With Which the Proposed HD National Program Is Not Entirely Consistent, and Why the Agencies Have Chosen a Different Path

(a) Should the agencies regulate final-stage manufacturers?

The committee recommended that NHTSA regulate the final stage manufacturers since they have the greatest control over the design of the vehicle and its major subsystems that affect fuel consumption.[504] However, this recommendation was predicated on a regulatory system that regulated the whole vehicle as a single unit.

The agencies are proposing to regulate final-stage manufacturers for HD pickup trucks and vans, but not for vocational

[487] *See* Section II of this preamble.

[488] *See* Note 453 above, at 50, Finding 3–4.

[489] *Id.* at 128, Recommendation 5–1.

[490] *Id.* at 39, Finding 2–4.

[491] *See* Section II of this preamble.

[492] *See* Note 453 above at 157, Recommendation 6–1.

[493] *Id.* at 156, Finding 6–12.

[494] *Id.,* Finding 6–9.

[495] *Id.,* Finding 6–10.

[496] *Id.,* Finding 6–11.

[497] *Id.* Finding 6–12. Of particular concern is the potential for fleets to purchase vehicles classified for purposes of our regulations as "vocational" vehicles, in order to avoid the significant capital costs associated with the addition of aero improvements, weight reductions, and an APU, and then convert them to a tractor. The agencies believe we have addressed this potential loophole, as discussed in Section V.

[498] *See* Note 453 above, Finding 6–13.

[499] *Id.,* Finding 6–14.

[500] *Id.* at 156–157, Findings 6–16 and 6–17.

[501] *Id.* at 156, Finding 6–16.

[502] *Id.,* Finding 6–11.

[503] *See* Section VIII of this preamble and Chapter 9 of the draft RIA.

[504] *See* Note 453 above at 189, Recommendation 8–1.

vehicles or for Class 7–8 combination tractors. While choosing not to regulate the whole vehicle as a single unit for this first phase of the HD National Program means that the agencies' initial rule will not achieve the maximum potential benefits sought by NAS through its approach, the agencies believe that the benefits of implementing regulations more quickly outweigh the drawbacks. Additionally, the proposed HD National Program approach eliminates dealing with thousands of final-stage manufacturers in the first phase of regulations, many of whom are small businesses and could be unduly affected by these regulations in this time frame.

(b) What should the agencies do about component testing data?

The committee recommended that, in order to ensure consistent data from component manufacturers for certification and compliance modeling, NHTSA establish a standardized test protocol and safeguards for the confidentiality of that component data.[505] To that end, the committee recommended that NHTSA implement as soon as possible a major engineering contract to analyze several actual vehicles in several applications and develop an approach to component testing data in conjunction with vehicle simulation modeling to arrive at LSFC data for these vehicles.[506]

The agencies believe that these concerns are less of an issue with the proposed HD National Program. As discussed above, test protocols for HD pickup trucks and vans test protocols are already standardized, and both the agencies and the manufacturers know what to expect in the data. Additionally, for Classes 3 to 8, we know what to expect in the engine testing and data, and since the vehicle testing uses a simplified bin approach, even though there may be some loss of accuracy and potential for gaming, the agencies believe that this is the fastest way to get regulations implemented while addressing the problem of a lack of standardized test protocol/safeguards for data. The agencies anticipate addressing this issue on an ongoing basis in subsequent rulemakings for later phases of the HD National Program.

(c) How should the agencies validate a combined vehicle simulation/ component testing compliance approach?

The committee recommended that actual vehicles should also be tested by appropriate full-scale test procedures to confirm actual LSFC values and reductions measured with fuel consumption reduction technologies, as compared to the more cost-effective fleet certification approach.[507]

As discussed above, the agencies believe that this is less of a concern for the proposed HD National Program since the agencies are not proposing to regulate the whole vehicle as a single system. The agencies will continue to conduct tests of complete vehicles for audit purposes as the HD National Program develops and as time and resources allow.

(d) How should the agencies consider HD Regulation in Europe and Japan?

The committee suggested that the HD fuel consumption regulations in Japan, and those under consideration and study by the European Commission, provide valuable input and experience to the U.S. plans. The committee stated that in Japan the complexity of HD vehicle configurations and duty cycles was determined to lend itself to the use of computer simulation as a cost-effective means to calculate fuel efficiency, and that the EC studies so far indicate plans to develop and use simulations in their expected regulatory system. The committee noted that Japan is not using extensive full-vehicle testing in the certification process, despite the fact that its HD vehicle manufacturing diversity is less than in the United States, with relatively few HD vehicle manufacturers and no independent engine companies.

The agencies have reviewed the Japanese and planned EC HD regulations to the extent possible given the time frame for this rulemaking and considered those approaches. However, the proposed HD National Program differs from the Japanese and planned EC HD programs. The agencies agree that international harmonization in HD fuel consumption/GHG regulations is desirable and expect harmonization may increase over time, given the global presence of many HD vehicle manufacturers.

(e) How much engineering work needs to be done before HD fuel consumption regulations can be implemented?

The committee stated that significant engineering work is needed to produce a regulatory approach that produces cost effective and accurate results, which can provide meaningful data to vehicle purchasers.[508] While the agencies emphasize that much engineering work has already been undertaken in support of this proposed HD National Program, we believe, as discussed above, that the need for engineering work perceived by NAS is reduced somewhat based on the structure of the proposed program. Since the agencies are not regulating transmission ratios, final drive ratio, and tire size; since the agencies are not regulating the complete vehicle as a single unit and instead separating the engine from the vehicle; and since the agencies are building off of existing regulatory programs for light-duty vehicles and HD criteria pollutant emissions wherever possible, we believe that we have created a solid basis for the HD National Program that will address NAS' concerns in this regard.

XI. Statutory and Executive Order Reviews

(1) Executive Order 12866: Regulatory Planning and Review

Under section 3(f)(1) of Executive Order 12866 (58 FR 51735, October 4, 1993), this action is an "economically significant regulatory action" because it is likely to have an annual effect on the economy of $100 million or more. Accordingly, the agencies submitted this action to the Office of Management and Budget (OMB) for review under Executive Order 12866 and any changes made in response to OMB recommendations have been documented in the docket for this action.

NHTSA is also subject to the Department of Transportation's Regulatory Policies and Procedures. These proposed rules are also significant within the meaning of the DOT Regulatory Policies and Procedures. Executive Order 12866 additionally requires NHTSA to submit this action to OMB for review and document any changes made in response to OMB recommendations.

In addition, the agencies prepared an analysis of the potential costs and benefits associated with this action. This analysis is contained in the Draft Regulatory Impact Analysis, which is available in the docket for this proposal and at the docket Internet address listed under **ADDRESSES** above.

(2) National Environmental Policy Act

Concurrently with this NPRM, NHTSA is releasing a Draft

[505] *Id.*

[506] *Id.* at 190, Recommendation 8–5.

[507] *Id.* at 190, Recommendation 8–4.

[508] *Id.* at 190, Finding 8–13.

Environmental Impact Statement (DEIS), pursuant to the National Environmental Policy Act, 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. NHTSA prepared the DEIS to analyze and disclose the potential environmental impacts of the proposed HD fuel consumption standards and reasonable alternatives. The DEIS analyzes direct, indirect, and cumulative impacts and analyzes impacts in proportion to their significance.

Because of the link between the transportation sector and GHG emissions, the DEIS considers the possible impacts on climate and global climate change in the analysis of the effects of these fuel consumption standards. The DEIS also describes potential environmental impacts to a variety of resources. Resources that may be affected by the proposed action and alternatives include 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.

For additional information on NHTSA's NEPA analysis, please *see* the DEIS.

(3) Paperwork Reduction Act

The information collection requirements in this proposal have been submitted for approval to OMB under the *Paperwork Reduction Act,* 44 U.S.C. 3501 *et seq*. The Information Collection Request (ICR) document prepared by EPA has been assigned EPA ICR number 2394.01.

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 manufacturers. Section 208(a) of the CAA requires that vehicle 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.

It is estimated that this collection affects approximately 35 engine and vehicle manufacturers. 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.

The burden to the manufacturers affected by this proposal has a range based on the number of engines and vehicles a manufacturer produces. The total estimated burden associated with this proposal is 25,052 hours annually (*see* Table XI–1:). This estimated burden for engine and vehicle manufacturers is a total estimate for new reporting requirements. 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 XI-1: Burden for Reporting and Recordkeeping Requirements

Number of Affected Vehicle Manufacturers	34
Annual Labor Hours for Each Manufacturer to Prepare and Submit Required Information	Varies
Total Annual Information Collection Burden	25,052 Hours

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 are listed in 40 CFR part 9.

To comment on the agencies' needs for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques, EPA has established a public docket for this proposal, which includes this ICR, under Docket ID number EPA–HQ–OAR–2010–0162. Submit any comments related to the ICR for this proposal to EPA and OMB. *See* the **ADDRESSES** section at the beginning of this notice for where to submit comments to EPA. Send comments to OMB at the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th Street, NW., Washington, DC 20503, Attention: Desk Office for EPA. Since OMB is required to make a decision concerning the ICR between 30 and 60 days after November 30, 2010, a comment to OMB is best assured of having its full effect if OMB receives it by December 30, 2010. The final rules will respond to any OMB or public comments on the information collection requirements contained in this proposal.

(4) Regulatory Flexibility Act

(a) Overview

The Regulatory Flexibility Act 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 this proposal on small entities, small entity is defined as: (1) A small business as defined by SBA regulations at 13 CFR 121.201 (*see* Table XI–2 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 XI–2 provides an overview of the primary SBA small business categories included in the heavy-duty engine and vehicle sector:

Table XI-2: Primary SBA Small Business Categories in the Heavy-Duty Engine and Vehicle Sector

Industry [a]	Defined as small entity by SBA if less than or equal to:	NAICS Codes[b]
Motor vehicle manufacturers, engine and truck manufacturers	1,000 employees	336111 336112 336120
Commercial importers of vehicles and vehicle components	$7.0 million annual revenue	811112 811198 541514
Alternative fuel vehicle converters Sec. 42 –Wholesale trade is not applicable to government procurement of supplies	500 employees 1,000 employees	336111 336112 422720 454312 541514 541690 811198
Truck trailer manufacturers	500 employees	336212

Notes:
[a] Heavy-duty engine and vehicle entities that qualify as small businesses would not be subject to these proposed rules. We are deferring action on small vehicle entities, and we intend to address these entities in a future rule.
[b] North American Industrial Classification System.

(b) Summary of Potentially Affected Small Entities

The agencies have not conducted an Initial Regulatory Flexibility Analysis for the proposal because we are proposing to certify that these rules would not have a significant economic impact on a substantial number of small entities. The agencies are proposing to defer standards for manufacturers meeting SBA's definition of small business as described in 13 CFR 121.201 due to the short lead time to develop this proposal, the extremely small fuel savings and emissions contribution of these entities, and the potential need to develop a program that would be structured differently for them (which would require more time). The agencies would instead consider appropriate fuel consumption and GHG emissions standards for these entities as part of a future regulatory action. This includes small entities in several distinct categories of businesses for heavy-duty engines and vehicles: chassis manufacturers, combination tractor manufacturers, and alternative fuel engine converters.

Based on preliminary assessment, the agencies have identified a total of about 17 engine manufacturers, 3 complete pickup truck and van manufacturers, 11 combination tractor manufacturers and 43 heavy-duty chassis manufacturers. Notably, several of these manufacturers produce vehicles in more than just one regulatory category (HD pickup trucks/vans, combination tractors, or vocational vehicles (*i.e.* heavy-duty chassis manufacturers)). Based on the types of vehicles they manufacture, these companies, however, would be subject to slightly different testing and reporting requirements. Taking this feature of the heavy-duty trucking sector into account, the agencies estimate that although there are fewer than 30 manufacturers covered by the proposal, there are close to 60 divisions with these companies that would be subject to the proposed regulations. Of these, about 15 entities fit the SBA criteria of a small business. There are approximately three engine converters, two tractor manufacturers, and ten heavy-duty chassis manufacturers in the heavy-duty engine and vehicle market that are small businesses. (No major heavy-duty engine manufacturers, heavy-duty chassis manufacturers, or tractor manufacturers meet the small-entity criteria as defined by SBA). The agencies estimate that these small entities comprise less than 0.35 percent of the total heavy-duty vehicle sales in the United States, and therefore the proposed deferment will have a negligible impact on the fuel consumption and GHG emissions reductions from the proposed standards.

To ensure that the agencies are aware of which companies would be deferred, the agencies are proposing that such entities submit a declaration to the agencies containing a detailed written description of how that manufacturer qualifies as a small entity under the provisions of 13 CFR 121.201. Some small entities, such as heavy-duty tractor and chassis manufacturers, are not currently covered under criteria pollutant motor vehicle emissions regulations. Small engine entities are currently covered by a number of EPA motor vehicle emission regulations, and they routinely submit information and data on an annual basis as part of their compliance responsibilities. Because such entities are not automatically exempted from other EPA regulations for heavy-duty engines and vehicles, absent such a declaration, EPA would assume that the entity was subject to the greenhouse gas control requirements in this GHG proposal. The declaration to the agencies would need to be submitted at time of either engine or vehicle emissions certification under the Heavy-duty Highway Engine program. The agencies expect that the additional paperwork burden associated with completing and submitting a small entity declaration to gain deferral from the proposed GHG and fuel consumption standards would be negligible and easily done in the context of other routine submittals to the agencies. However, the agencies have accounted for this cost with a nominal estimate included in the Information Collection Request completed under the Paperwork Reduction Act. Additional information can be found in the Paperwork Reduction Act discussion in Section XI. (3) Paperwork Reduction Act. Based on this, the agencies are proposing to certify that the rules would not have a significant economic impact on a substantial number of small entities. The agencies continue to be interested in the potential impacts of the proposal on small entities and welcome comments on issues related to such impacts.

(c) Conclusions

We therefore certify that this proposal will not have a significant economic impact on a substantial number of small entities.

(5) Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), Public Law 104–4, establishes requirements for Federal agencies to assess the effects of their regulatory actions on State, local, and Tribal governments and the private sector. Under section 202 of the UMRA, the agencies generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with "Federal mandates" that may result in expenditures to State, local, and Tribal governments, in the aggregate, or to the private sector, of $100 million or more in any one year. Before promulgating a rule for which a written statement is needed, section 205 of the UMRA generally requires the agencies to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows the agencies to adopt an alternative other than the least costly, most cost-effective or least burdensome alternative if the Administrator (of either agency) publishes with the final rule an explanation why that alternative was not adopted.

Before the agencies establish any regulatory requirements that may significantly or uniquely affect small governments, including Tribal governments, they must have developed under section 203 of the UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA and NHTSA regulatory proposals with significant Federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

This proposal contains no Federal mandates (under the regulatory provisions of Title II of the UMRA) for State, local, or Tribal governments. The rules impose no enforceable duty on any State, local or Tribal governments. The agencies have determined that this proposal contains no regulatory requirements that might significantly or uniquely affect small governments. The agencies have determined that this proposal contains a Federal mandate that may result in expenditures of $100 or more for the private sector in any one year. The agencies believe that the proposal represents the least costly, most cost-effective approach to achieve the statutory requirements of the rules. Section VIII.L, above, 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 VIII and in the Draft Regulatory Impact Analysis, as required by the UMRA.

Table XI–3 presents the rule-related benefits, costs and net benefits in both present value terms and in annualized terms. In both cases, the discounted values are based on an underlying time varying stream of cost and benefit values that extend into the future (2012 through 2050). The distribution of each monetized economic impact over time can be viewed in the RIA that accompanies this proposal.

Present values represent the *total* amount that a stream of monetized costs/benefits/net benefits that occur over time are worth now (in year 2008 dollar terms for this analysis), accounting for the time value of money by discounting future values using either a 3 or 7 percent discount rate, per OMB Circular A–4 guidance. An annualized value takes the present value and converts it into a *constant stream of annual values* through a given time period (2012 through 2050 in this analysis) and thus averages (in present value terms) the annual values. The present value of the constant stream of annualized values equals the present value of the underlying time varying stream of values. The ratio of benefits to costs is identical whether it is measured with present values or annualized values.

It is important to note that annualized values cannot simply be summed over time to reflect total costs/benefits/net benefits; they must be discounted and summed. Additionally, the annualized value can vary substantially from the time varying stream of cost/benefit/net benefit values that occur in any given year (*e.g.,* the stream of costs represented by $0.34B and $0.58B in Table XI–3 below average $1.5B from 2014 through 2018 and are zero from 2019–2050).

Table XI-3: Estimated Lifetime and Annualized Discounted Costs, Benefits, and Net Benefits for 2014-2018 Model Year HD Vehicles assuming the $22/ton SCC Value[a,b] (billions 2008 dollars)

Lifetime Present value[c,d] – 3% Discount Rate	
Costs	$7.7
Benefits	$49
Net Benefits	$41
Annualized value[c,e] – 3% Discount Rate	
Costs	$0.34
Benefits	$2.1
Net Benefits	$1.8
Lifetime Present value[c,d] - 7% Discount Rate	
Costs	$7.7
Benefits	$34
Net Benefits	$27
Annualized value[c,e] – 7% Discount Rate	
Costs	$0.58
Benefits	$2.6
Net Benefits	$2.0

Notes:

[a] Although the agencies estimated the benefits associated with four different values of a one ton CO_2 reduction (SCC: $5, $22, $36, $66), for the purposes of this overview presentation of estimated costs and benefits we are showing the benefits associated with the marginal value deemed to be central by the interagency working group on this topic: $22 per ton of CO_2, in 2008 dollars and 2010 emissions and fuel consumption. As noted in Section VIII.G, SCC increases over time.

[b] Note that net present value of reduced GHG emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5, 3, and 2.5 percent) is used to calculate net present value of SCC for internal consistency. Refer to Section VIII.G for more detail.

[c] Discounted values presented in this table are based on an underlying series of cost and benefit values that extend into the future (2012 through 2050). The distribution of each monetized economic impact over time can be viewed in the RIA that accompanies this

[d] Present value is the total, aggregated amount that a series of monetized costs or benefits that occur over time is worth now (in year 2008 dollar terms), discounting future values to the present.

[e] The annualized value is the constant annual value through a given time period (2012 through 2050 in this analysis) whose summed present value equals the present value from which it was derived.

(6) 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, as specified in Executive Order 13132. This proposal would apply to manufacturers of motor vehicles and not to State or local governments. Thus, Executive Order 13132 does not apply to this action. Although section 6 of Executive Order 13132 does not apply to this action, the agencies did consult with representatives of State governments in developing this action.

In the spirit of Executive Order 13132, and consistent with EPA and NHTSA policy to promote communications between the agencies and State and local governments, the agencies specifically solicit comment on this proposed action 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). Accordingly, NHTSA has tentatively concluded that EPCA's express preemption provision would not reach the fuel efficiency standards to be established in this rulemaking.

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 comments on this issue.

(7) Executive Order 13175 (Consultation and Coordination With Indian Tribal Governments)

These proposed rules do not have Tribal implications, as specified in Executive Order 13175 (65 FR 67249, November 9, 2000). This proposal will be implemented at the Federal level and impose compliance costs only on vehicle 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 proposal. The agencies specifically solicit additional comment on this proposal from Tribal officials.

(8) Executive Order 13045: "Protection of Children From Environmental Health Risks and Safety Risks"

This action is subject to Executive Order 13045 (62 FR 19885, April 23, 1997) 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. 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.[509] A summary of the analysis is presented below.

With respect to GHG emissions, the effects of climate change observed to date and projected to occur in the future include the increased likelihood of more frequent and intense heat waves. Specifically, EPA's analysis of the scientific assessment literature has determined that severe heat waves are projected to intensify in magnitude, frequency, and duration over the portions of the United States where these events already occur, with potential increases in mortality and morbidity, especially among the young, elderly, and frail. EPA has estimated reductions in projected global mean surface temperatures as a result of reductions in GHG emissions associated with the standards proposed in this action (Section II). Children may receive benefits from reductions in GHG emissions because they are included in the segment of the population that is most vulnerable to extreme temperatures.

For non-GHG pollutants, EPA has determined that climate change is expected to increase regional ozone pollution, with associated risks in respiratory infection, aggravation of asthma, and premature death. The directional effect of climate change on ambient PM levels remains uncertain. However, disturbances such as wildfires are increasing in the United States and are likely to intensify in a warmer future with drier soils and longer growing seasons. PM emissions from forest fires can contribute to acute and chronic illnesses of the respiratory system, particularly in children, including pneumonia, upper respiratory diseases, asthma and chronic obstructive pulmonary diseases.

The public is invited to submit comments or identify peer-reviewed studies and data that assess effects of early life exposure to the pollutants addressed by this proposal.

[509] *See* Endangerment TSD, Note 10, above.

(9) Executive Order 13211 (Energy Effects)

This proposal is not a "significant energy action" as defined in Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use" (66 FR 28355, May 22, 2001) 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 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 VIII.H.

(10) National Technology Transfer Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 ("NTTAA"), Public Law 104–113, 12(d) (15 U.S.C. 272 note) directs the agencies to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (*e.g.,* materials, specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs the agencies to provide Congress, through OMB, explanations when the agencies decide not to use available and applicable voluntary consensus standards.

For CO_2, N_2O, and CH_4 emissions and fuel consumption from heavy-duty engines, the agencies are proposing to collect data over the same tests that are used for the Heavy-duty Highway Engine program. This will minimize the amount of testing done by manufacturers, since manufacturers are already required to run these tests.

For CO_2, N_2O, and CH_4 emissions and fuel consumption from complete pickup trucks and vans, the agencies are proposing to collect data over the same tests that are used for the Heavy-duty Highway Engine program and California Air Resources Board. This will minimize the amount of testing done by manufacturers, since manufacturers are already required to run these tests.

For CO_2 emissions and fuel consumption from heavy-duty combination tractors and vocational vehicles, the agencies are proposing to collect data through the use of a simulation model instead of a full-vehicle chassis dynamometer testing. This will minimize the amount of testing done by manufacturers. EPA's compliance assessment tool is based upon well-established engineering and physics principals that are the basis of general academic understanding in this area, and the foundation of any dynamic vehicle simulation model, including the models cited by ICCT in its study.[510] Therefore, the EPA's compliance assessment tool satisfies the description of a consensus. For the evaluation of tire rolling resistance input to the model, EPA is proposing to use the ISO 28580 test, a voluntary consensus methodology. EPA is proposing to allow several alternatives for the evaluation of aerodynamics which allows the industry to continue to use their own evaluation tools because EPA does not know of a single consensus standard available for heavy-duty truck aerodynamic evaluation.

For air conditioning standards, EPA is proposing to use a consensus methodology developed by the Society of Automotive Engineers (SAE).

(11) Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order 12898 (59 FR 7629, February 16, 1994) establishes Federal executive policy on environmental justice. Its main provision directs Federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

[510] ICCT. ICCT Evaluation of Vehicle Simulation Tools. 2009.

With respect to GHG emissions, EPA has determined that these proposed rules will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases 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 or low-income population. The reductions in CO_2 and other GHGs associated with the standards will affect climate change projections, and EPA has estimated reductions in projected global mean surface temperatures (Section VI). Within communities experiencing 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.[511] In addition, the U.S. Climate Change Science Program[512] stated as one of its conclusions: "The United States is certainly capable of adapting to the collective impacts of climate change. However, there will still be certain individuals and locations where the adaptive capacity is less and these individuals and their communities will be disproportionally impacted by climate change." Therefore, these specific sub-populations may receive benefits from reductions in GHGs.

For non-GHG co-pollutants such as ozone, $PM_{2.5}$, and toxics, EPA has concluded that it is not practicable to determine whether there would be disproportionately high and adverse human health or environmental effects on minority and/or low income populations from this proposal.

The public is invited to submit comments or identify peer-reviewed studies and data that assess effects of early life exposure to the pollutants addressed by this proposal.

XII. Statutory Provisions and Legal Authority

A. EPA

Statutory authority for the vehicle controls in this proposal are found in CAA section 202(a) (which authorizes standards for emissions of pollutants from new motor vehicles which emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare), sections 202(d), 203–209, 216, and 301 of the CAA, 42 U.S.C. 7521(a), 7521(d), 7522, 7523, 7524, 7525, 7541, 7542, 7543, 7550, and 7601.

[511] *See* Endangerment TSD, Note 10, above.

[512] CCSP (2008) *Analyses of the effects of global change on human health and welfare and human systems.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA.

B. NHTSA

Statutory authority for the fuel consumption standards in this proposal is found in EISA section 103 (which 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) of the Energy Independence and Security Act of 2007, 49 U.S.C. 32902(k).

List of Subjects

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, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Parts 1036 and 1037

Administrative practice and procedure, Air pollution control, Confidential business information, Environmental protection, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Warranties.

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

Environmental protection, Administrative practice and procedure, Confidential business information, Imports, Incorporation by reference, Motor vehicle pollution, Penalties, Reporting and recordkeeping requirements, Warranties.

49 CFR Parts 523, 534, and 535

Fuel economy.

Environmental Protection Agency

40 CFR Chapter I

For the reasons set forth in the preamble, the Environmental Protection Agency proposes to amend 40 CFR chapter I of the Code of Federal Regulations as follows:

PART 85—CONTROL OF AIR POLLUTION FROM MOBILE SOURCES

1. The authority citation for part 85 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart P—[Amended]

Section 85.1511 is revised to read as follows:

§ 85.1511 Exemptions and exclusions.

(a) Individuals, as well as certificate holders, shall be eligible for importing vehicles into the United States under the provisions of this section, unless otherwise specified.

(b) Notwithstanding any other requirements of this subpart, a motor vehicle or motor vehicle engine entitled to a temporary exemption under this paragraph (b) may be conditionally admitted into the United States if prior written approval for such conditional admission is obtained from the Administrator. Conditional admission shall be under bond. A written request for approval from the Administrator shall contain the identification required in § 85.1504(a)(1) (except for § 85.1504(a)(1)(v)) and information that indicates that the importer is entitled to the exemption. Noncompliance with provisions of this section may result in the forfeiture of the total amount of the bond or exportation of the vehicle or engine. The following temporary exemptions are permitted by this paragraph (b):

(1) *Exemption for repairs or alterations.* Vehicles and engines may qualify for a temporary exemption under the provisions of 40 CFR 1068.325(a). Such vehicles or engines may not be registered or licensed in the United States for use on public roads and highways.

(2) *Testing exemption.* Vehicles and engines may qualify for a temporary exemption under the provisions of 40 CFR 1068.325(b). Test vehicles or engines may be operated on and registered for use on public roads or highways provided that the operation is an integral part of the test.

(3) *Precertification exemption.* Prototype vehicles for use in applying to EPA for certification may be imported by independent commercial importers subject to applicable provisions of 40 CFR 85.1706 and the following requirements:

(i) No more than one prototype vehicle for each engine family for which an independent commercial importer is seeking certification shall be imported by each independent commercial importer.

(ii) Unless a certificate of conformity is issued for the prototype vehicle, the total amount of the bond shall be forfeited or the vehicle must be exported within 180 days from the date of entry.

(4) *Display exemptions.* Vehicles and engines may qualify for a temporary exemption under the provisions of 40 CFR 1068.325(c). Display vehicles or engines may not be registered or licensed for use or operated on public roads or highways in the United States, unless an applicable certificate of conformity has been received.

(c) Notwithstanding any other requirements of this subpart, a motor vehicle or motor vehicle engine may be finally admitted into the United States under this paragraph (c) if prior written approval for such final admission is obtained from the Administrator. Conditional admission of these vehicles is not permitted for the purpose of obtaining written approval from the Administrator. A request for approval shall contain the identification information required in § 85.1504(a)(1) (except for § 85.1504(a)(1)(v)) and information that indicates that the importer is entitled to the exemption or exclusion. The following exemptions or exclusions are permitted by this paragraph (c):

(1) *National security exemption.* Vehicles may be imported under the national security exemption found at 40 CFR 1068.315(a). Only persons who are manufacturers may import a vehicle under a national security exemption.

(2) *Hardship exemption.* The Administrator may exempt on a case-by-case basis certain motor vehicles from Federal emission requirements to accommodate unforeseen cases of extreme hardship or extraordinary circumstances. Some examples are as follows:

(i) Handicapped individuals who need a special vehicle unavailable in a certified configuration;

(ii) Individuals who purchase a vehicle in a foreign country where resale is prohibited upon the departure of such an individual;

(iii) Individuals emigrating from a foreign country to the U.S. in circumstances of severe hardship.

(d) Foreign diplomatic and military personnel may import nonconforming vehicles without bond. At the time of admission, the importer shall submit to the Administrator the written report required in § 85.1504(a)(1) (except for information required by § 85.1504(a)(1)(v)). Such vehicles may not be sold in the United States.

(e) Racing vehicles may be imported by any person provided the vehicles meet one or more of the exclusion criteria specified in § 85.1703. Racing vehicles may not be registered or licensed for use on or operated on public roads and highways in the United States.

(f) The following exclusions and exemptions apply based on date of original manufacture:

(1) Notwithstanding any other requirements of this subpart, the following motor vehicles or motor vehicle engines are excluded from the requirements of the Act in accordance with section 216(3) of the Act and may be imported by any person:

(i) Gasoline-fueled light-duty vehicles and light-duty trucks originally manufactured prior to January 1, 1968.

(ii) Diesel-fueled light-duty vehicles originally manufactured prior to January 1, 1975.

(iii) Diesel-fueled light-duty trucks originally manufactured prior to January 1, 1976.

(iv) Motorcycles originally manufactured prior to January 1, 1978.

(v) Gasoline-fueled and diesel-fueled heavy-duty engines originally manufactured prior to January 1, 1970.

(2) Notwithstanding any other requirements of this subpart, a motor vehicle or motor vehicle engine not subject to an exclusion under paragraph (f)(1) of this section but greater than twenty OP years old is entitled to an exemption from the requirements of the Act, provided that it is imported into the United States by a certificate holder. At the time of admission, the certificate holder shall submit to the Administrator the written report required in § 85.1504(a)(1) (except for information required by § 85.1504(a)(1)(v)).

(g) Applications for exemptions and exclusions provided for in paragraphs (b) and (c) of this section shall be mailed to the Designated Compliance Officer (*see* 40 CFR 1068.30).

(h) Vehicles conditionally or finally admitted under this section must still comply with all applicable requirements, if any, of the Energy Tax Act of 1978, the Energy Policy and Conservation Act and any other Federal or State requirements.

PART 86—CONTROL OF EMISSIONS FROM NEW AND IN-USE HIGHWAY VEHICLES AND ENGINES

3. The authority citation for part 86 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart A—[Amended]

4. Section 86.007–23 is amended by adding paragraph (o) to read as follows:

§ 86.007–23 Required data.

* * * * *

(o) The provisions of this paragraph (o) apply starting with the 2014 model year. For heavy-duty engines tested over the transient engine test cycle, manufacturers must show individual measurements for cold-start testing and hot-start testing. For heavy-duty engines testing over the SET cycle, manufacturers must show individual results for each steady-state test mode for each pollutant except PM.

5. A new § 86.016–1 is added to subpart A to read as follows:

§ 86.016–1 General applicability.

(a) *Applicability.* The provisions of this subpart generally apply to 2005 and later model year new Otto-cycle heavy-duty engines used in incomplete vehicles and vehicles above 14,000 pounds GVWR and 2005 and later model year new diesel-cycle heavy-duty engines. In cases where a provision applies only to a certain vehicle group based on its model year, vehicle class, motor fuel, engine type, or other distinguishing characteristics, the limited applicability is cited in the appropriate section or paragraph. The provisions of this subpart continue to generally apply to 2000 and earlier model year new Otto-cycle and diesel-cycle light-duty vehicles, 2000 and earlier model year new Otto-cycle and diesel-cycle light-duty trucks, and 2004 and earlier model year new Otto-cycle complete heavy-duty vehicles at or below 14,000 pounds GVWR. Provisions generally applicable to 2001 and later model year new Otto-cycle and diesel-cycle light-duty vehicles, 2001 and later model year new Otto-cycle and diesel-cycle light-duty trucks, and 2005 and later model year Otto-cycle complete heavy-duty vehicles at or below 14,000 pounds GVWR are located in subpart S of this part.

(b) *Optional applicability.* A manufacturer may request to certify any incomplete Otto-cycle heavy-duty vehicle of 14,000 pounds Gross Vehicle Weight Rating or less in accordance with the provisions for Otto-cycle complete heavy-duty vehicles located in subpart S of this part. Heavy-duty engine or heavy-duty vehicle provisions of this subpart A do not apply to such a vehicle.

(c) *Otto-cycle heavy-duty engines and vehicles.* The following requirements apply to Otto-cycle heavy-duty engines and vehicles:

(1) Exhaust emission standards according to the provisions of § 86.008–10 or § 86.1816, as applicable.

(2) On-board diagnostics requirements according to the provisions of § 86.007–17 or § 86.1806, as applicable.

(3) Evaporative emission standards as follows:

(i) Evaporative emission standards for complete vehicles according to the provisions of §§ 86.1810 and 86.1816.

(ii) For 2013 and earlier model years, evaporative emission standards for incomplete vehicles according to the provisions of § 86.008–10, or §§ 86.1810 and 86.1816, as applicable.

(iii) For 2014 and later model years, evaporative emission standards for incomplete vehicles according to the provisions of §§ 86.1810 and 86.1816, or 40 CFR part 1037, as applicable.

(4) Refueling emission requirements for Otto-cycle complete vehicles according to the provisions of §§ 86.1810 and 86.1816.

(d) *Non-petroleum fueled vehicles.* The standards and requirements of this part apply to model year 2016 and later non-petroleum fueled motor vehicles as follows:

(1) The standards and requirements of this part apply as specified for vehicles fueled with methanol, natural gas, and LPG.

(2) The standards and requirements of subpart S of this part apply as specified for light-duty vehicles and light-duty trucks.

(3) The standards and requirements of this part applicable to methanol-fueled heavy-duty vehicles and engines (including flexible fuel vehicles and engines) apply to heavy-duty vehicles and engines fueled with any oxygenated fuel (including flexible fuel vehicles and engines). Most significantly, this means that the hydrocarbon standards apply as NMHCE and the vehicles and engines must be tested using the applicable oxygenated fuel according to the test procedures in 40 CFR part 1065 applicable for oxygenated fuels. For purposes of this paragraph (d), oxygenated fuel means any fuel containing at least 50 volume percent oxygenated compounds. For example, a fuel mixture of 85 gallons of ethanol and 15 gallons of gasoline is an oxygenated fuel, while a fuel mixture of 15 gallons of ethanol and 85 gallons of gasoline is not an oxygenated fuel.

(4) The standards and requirements of subpart S of this part applicable to heavy-duty vehicles under 14,000 pounds GVWR apply to all heavy-duty vehicles powered solely by electricity, including plug-in electric vehicles and solar-powered vehicles. Use good engineering judgment to apply these requirements to these vehicles, including applying these provisions to vehicles over 14,000 pounds GVWR. Electric heavy-duty vehicles may not generate NO_X or PM emission credits. Heavy-duty vehicles powered solely by electricity are deemed to have zero emissions of regulated pollutants.

(5) The standards and requirements of this part applicable to diesel-fueled heavy-duty vehicles and engines apply to all other heavy-duty vehicles and engines not otherwise addressed in this paragraph (d).

(6) *See* 40 CFR parts 1036 and 1037 for requirements related to greenhouse gas emissions.

(7) Manufacturers may voluntarily certify to the standards of paragraphs (d)(3) through (5) of this section before model year 2016. Note that other provisions in this part require compliance with the standards described in paragraphs (d)(1) and (2) of this section for model years before 2016.

(e) *Small volume manufacturers.* Special certification procedures are available for any manufacturer whose projected combined U.S. sales of light-duty vehicles, light-duty trucks, heavy-duty vehicles, and heavy-duty engines in its product line (including all vehicles and engines imported under the provisions of 40 CFR 85.1505 and 85.1509 of this chapter) are fewer than 10,000 units for the model year in which the manufacturer seeks certification. To certify its product line under these optional procedures, the small-volume manufacturer must first obtain the Administrator's approval. The manufacturer must meet the eligibility criteria specified in § 86.092–14(b) before the Administrator's approval will be granted. The small-volume manufacturer's certification procedures are described in § 86.092–14.

(f) *Optional procedures for determining exhaust opacity.* (1) The provisions of subpart I of this part apply to tests which are performed by the Administrator, and optionally, by the manufacturer.

(2) Measurement procedures, other than those described in subpart I of this part, may be used by the manufacturer provided the manufacturer satisfies the requirements of § 86.091–23(f).

(3) When a manufacturer chooses to use an alternative measurement procedure it has the responsibility to determine whether the results obtained by the procedure will correlate with the results which would be obtained from the measurement procedure in subpart I of this part. Consequently, the

Administrator will not routinely approve or disapprove any alternative opacity measurement procedure or any associated correlation data which the manufacturer elects to use to satisfy the data requirements for subpart I of this part.

(4) If a confirmatory test(s) is performed and the results indicate there is a systematic problem suggesting that the data generated under an optional alternative measurement procedure do not adequately correlate with data obtained in accordance with the procedures described in subpart I of this part, EPA may require that all certificates of conformity not already issued be based on data obtained from procedures described in subpart I of this part.

Subpart N—[Amended]

6. Section 86.1305–2010 is amended by revising paragraph (b) to read as follows:

§ 86.1305–2010 Introduction; structure of subpart.

* * * * *

(b) Use the applicable equipment and procedures for spark-ignition or compression-ignition engines in 40 CFR part 1065 to determine whether engines meet the duty-cycle emission standards in subpart A of this part. Measure the emissions of all regulated pollutants as specified in 40 CFR part 1065. Use the duty cycles and procedures specified in §§ 86.1333–2010, 86.1360–2007, and 86.1362–2010. Adjust emission results from engines using aftertreatment technology with infrequent regeneration events as described in § 86.004–28.

* * * * *

7. Section 86.1362–2010 is amended by adding paragraph (f) to read as follows:

§ 86.1362–2010 Steady-state testing with a ramped-modal cycle.

* * * * *

(f) Starting in the 2014 model year, use continuous sampling to determine separate emission rates at each test mode during the test run for each pollutant except PM, as described in 40 CFR 1036.501.

Subpart S—[Amended]

8. Section 86.1863–07 is revised to read as follows:

§ 86.1863–07 Chassis certification for diesel vehicles.

(a) A manufacturer may optionally certify heavy-duty diesel vehicles 14,000 pounds GVWR or less to the standards specified in § 86.1816. Such vehicles must meet all the requirements of subpart S of this part that are applicable to Otto-cycle vehicles, except for evaporative, refueling, and OBD requirements where the diesel-specific OBD requirements would apply.

(b) For OBD, diesel vehicles optionally certified under this section are subject to the OBD requirements of § 86.1806.

(c) Diesel vehicles certified under this section may be tested using the test fuels, sampling systems, or analytical systems specified for diesel engines in subpart N of this part or in 40 CFR part 1065.

(d) Diesel vehicles optionally certified under this section to the standards of this subpart may not be included in any averaging, banking, or trading program under this part.

(e) The provisions of § 86.004–40 apply to the engines in vehicles certified under this section.

(f) Diesel vehicles may be certified under this section to the standards applicable to model year 2008 in earlier model years.

(g) Diesel vehicles optionally certified under this section in model years 2007, 2008, or 2009 shall be included in phase-in calculations specified in § 86.007–11(g).

(h) Diesel vehicles subject to the standards of 40 CFR 1037.104 are subject to the provisions of this subpart as specified in 40 CFR 1037.104.

9. A new part 1036 is added to subchapter U 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—[Reserved]

Subpart E—In-Use Testing

Subpart F—Test Procedures

Subpart G—Special Compliance Provisions

Subpart H—Averaging, Banking, and Trading for Certification

Subpart I—Definitions and Other Reference Information

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 to all new 2014 model year and later heavy-duty engines. This includes engines fueled by conventional and alternative fuels.

(b) This part does not apply with respect to exhaust emission standards for HC, CO, NO_X, or PM except that the provisions of § 1036.601 apply.

§ 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. The term "you" generally means the engine manufacturer, especially for issues related to certification.

§ 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 that are subject to regulation under 40 CFR part 86, subpart S, except as specified in 40 CFR part 86, subpart S. For example, this exclusion applies for engines used in vehicles certified to the standards of 40 CFR 1037.104.

(b) Engines installed in heavy-duty vehicles that do not provide motive power are nonroad engines. The provisions of this part therefore do not apply to these engines. *See* 40 CFR parts 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.

§ 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 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) [Reserved]

(j) Subpart J 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, including 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.

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 gas pollutants described in 40 CFR 1037.104 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 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 1037.104.

(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). For medium and heavy heavy-duty engines used in tractors, measure emissions using only the steady-state duty cycle specified in 40 CFR part 86, subpart N (referred to as the SET cycle). For medium and heavy heavy-duty engines used in both tractors and vocational applications, measure emissions using the steady-state duty cycle and the transient duty cycle (commonly referred to as the FTP engine cycle) specified in 40 CFR part 86, subpart N. For all other engines, measure emissions using only the 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 and all other engines (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 and later	576	576	555	487	460

(2) The CH_4 emission standard for all model year 2014 and later engines is 0.05 g/hp-hr when measured over the transient duty cycle specified in 40 CFR part 86, subpart N. Note that this standard applies for all fuel types just as the other standards of this section do.

(3) The N_2O emission standard for all model year 2014 and later engines is 0.05 g/hp-hr when measured over the transient duty cycle specified in 40 CFR part 86, subpart N.

(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 1.02.

(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. Except as specified in § 1036.705, you may not generate or use credits for N_2O or CH_4 emissions.

(d) *Useful life.* Your engines must meet the exhaust emission standards of this section over their full useful life, expressed in service miles 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.

(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), including certification, selective enforcement audits, and in-use testing. The FCLs serve as the 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 testing.

§ 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 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 the emission standards specified in 40 CFR 1037.103.

(2) For incomplete heavy-duty vehicles and 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 testing, you must make clear that the engine may be installed only 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) You do not need installation instructions for engines that you install in your own vehicles.

(d) 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) State the FEL(s) to which the engines are certified under this part. If you certify your engines for use in both vocational and tractor applications, include both the FEL for the transient FTP cycle and the SET cycle.

(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 steady-state testing, include the statement "TRACTORS 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.

You must identify a single primary intended service class for each compression-ignition engine family. Select the class that best describes the majority of engines from the engine family based on the applicable design and operating characteristics as follows:

(a) Light heavy-duty engines usually are non-sleeved and not designed for rebuild; their rated power generally ranges from 70 to 170 horsepower. Vehicle body types in this group might include any heavy-duty vehicle built for 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.

(b) Medium heavy-duty engines may be sleeved or non-sleeved and may be designed for rebuild. Rated power generally ranges from 170 to 250 horsepower. 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.

(c) Heavy heavy-duty engines are sleeved and designed for multiple rebuilds. Their rated power generally exceeds 250 horsepower. 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 emission credits for engines you certify in model year 2013 to the standards of § 1036.108. To do so, you must certify your entire U.S.-directed production volume within that averaging set to these standards. Calculate the emission credits as described in subpart H of this part relative to the standards that would apply for model year 2014. 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, manufacturers may show compliance with the N_2O standards using an engineering analysis.

(c) *Engine cycle classification.* 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. 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.

(d) *Small manufacturers.* Manufacturers meeting the small business criteria specified for "Gasoline Engine and Engine Parts Manufacturing" or "Other Engine Equipment Manufacturers" in 13 CFR 121.201 are not subject to the greenhouse gas emission standards in § 1036.108. Qualifying manufacturers must notify the Designated Compliance Officer before importing or introducing excluded engines into U.S. commerce. This notification must include a description of the manufacturer's qualification as a small business under 13 CFR 121.201.

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 as related 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.

(e) Identify the FCLs with which you are certifying engines in the engine family.

(f) Identify the engine family's deterioration factors and describe how you developed them (*see* § 1036.245). 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. Also show individual results by mode for steady-state testing for compression-ignition engines for each pollutant except PM.

(2) Note that §§ 1036.235 and 1036.245 allow you to submit an application in certain cases without new emission data.

(h) State whether your certification is limited for certain engines. This applies for engines such as the following:

(1) If you certify heavy heavy-duty engines to the CO_2 standards using only steady-state testing, the engines may be installed only in tractors.

(2) 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 other applicable information, such as information specified in this part or 40 CFR part 1068 related to requests for exemptions.

(l) 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.

§ 1036.210 May I get preliminary approval before I complete my application?

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.

(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 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 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 1.02. The changed FEL may not apply to engines you have already introduced into U.S. commerce, except as described in this paragraph (f). If we approve a changed FEL after the start of production, you must include the new FEL on the emission control information label for all engines produced after the change. 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, except as follows:

(a) Engines certified as hybrid engines or power packs may not be included in an engine family with engines with conventional powertrains. Note this does not preclude 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. You may assign the numbers and configurations of engines within the respective subfamilies at any time before submitting the end-of-year report required by § 1036.730. You must identify the type of vehicle in which each engine is installed, although we may allow you to use statistical methods to determine this for a fraction of your engines. Keep records to document this determination.

§ 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. 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. If you are certifying the engine for use only in tractors, you must measure emissions using the SET cycle. If you are certifying the engine for use only in vocational applications, you must measure emissions using the specified transient duty cycle, including cold-start and hot-start testing as specified in 40 CFR part 86, subpart N.

(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 at that test point. Unless we later invalidate these data, we may decide not to consider your data at that test point in determining if your engine family meets applicable requirements.

(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.

(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 or other characteristics unrelated to emissions.

(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 (b) 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 pollutant 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. Note that you may increase your FCL if any certification test results exceed your initial FCL.

(c) Do not apply deterioration factors to measured low-mileage emission levels from the emission-data engine unless good engineering judgment indicates that significant emission deterioration will occur during the useful life. However, where good engineering judgment indicates that significant emission deterioration will occur during the useful life, 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 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 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 exhaust emissions 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.

(d) Collect emission data using measurements to 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.

§ 1036.250 Reporting and recordkeeping for certification.

(a) [Reserved]

(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 data from routine emission tests (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).

(3) Render inaccurate any test data.

(4) Deny us from completing authorized activities despite our presenting a warrant or court order (*see* 40 CFR 1068.20). This includes a failure to provide reasonable assistance. However, you may ask us to reconsider our decision by showing that your failure under this paragraph (c)(4) did not involve engines related to the certificate or application in question to a degree that would justify our decision.

(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.

(d) We may void your certificate if you do not keep the records we require or do not give us information as required under this part or the Act.

(e) We may void your certificate if we find that you intentionally submitted false or incomplete information.

(f) If we deny your application or suspend, revoke, or void your certificate, you may ask for a hearing (*see* § 1036.820).

Subpart D—[Reserved]

Subpart E—In-Use Testing

§ 1036.401 In-use testing.

You must test your in-use engines as described in 40 CFR part 86, subpart T. We may perform in-use testing of any engine family subject to the standards of this part, consistent with the provisions of § 1036.235.

Subpart F—Test Procedures

§ 1036.501 How do I run a valid emission test?

(a) Use the equipment and procedures specified in 40 CFR 86.1305–2010 to determine whether engines meet the emission standards in § 1036.108.

(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, invalidate any test interval in which such a regeneration event occurs with respect to CO_2, N_2O, and CH_4 measurements.

(e) Test hybrid engines as described in 40 CFR part 1065 and § 1036.525.

(f) For compression-ignition engines, use continuous sampling to determine separate emission rates at each test mode during the test run over the ramped-modal cycle for each pollutant except PM. Perform this emission sampling using good engineering judgment by measuring emissions during the whole mode; do not measure emissions during the transitions between modes. Calculate emission results for each mode using the procedures of 40 CFR part 1065.

§ 1036.525 Hybrid engines.

(a) If your engine system includes features that recover and store energy during engine motoring operation, we may allow you to modify the test procedure calculations of 40 CFR part 1065, consistent with good engineering judgment, considering especially 40 CFR 1065.10(c)(1). *See* § 1036.615 for engine system intended to include features that recover and store energy from braking unrelated to engine motoring operation.

(b) If you produce a hybrid engine designed with PTO capability and sell the engine coupled with a transmission, you may calculate a reduction in CO_2 emissions resulting from the PTO 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) If your engine system requires special components for proper testing, you must provide any such components to us if we need to test your engine.

§ 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. Do not apply infrequent regeneration adjustment factors to your results.

(b) Adjust CO_2 emission rates calculated under paragraph (a) of this section for test fuel properties as specified in this paragraph (b) to obtain the official emission results. Note that the purpose of this adjustment is to make official emission results independent of small differences in test fuels within a fuel type.

(1) For liquid fuels, determine the net energy content (BTU per pound of fuel) and carbon weight fraction (dimensionless) of your test fuel according to ASTM D240–09 (incorporated by reference in § 1036.810). Use good engineering judgment to determine the net energy content and carbon weight fraction of your gaseous test fuel. (Note: Net energy content is also sometimes known as lower heating value.) Calculate the test fuel's carbon-specific net energy content (BTU/lbC) by dividing the net energy content by the carbon fraction and rounding to the nearest BTU/lbC.

(2) Calculate the adjustment factor for carbon-specific net energy content by dividing the carbon-specific net energy

content of your test fuel by the reference level in the following table and rounding to five decimal places.

Fuel Type	Reference carbon-specific net energy content (BTU/lbC)
Diesel fuel	21,200
Gasoline	21,700
Natural Gas	28,500
LPG	24,300

(3) Your official emission result equals your calculated brake-specific emission rate multiplied by the adjustment factor specified in paragraph (b)(2) of this section. For example, if the net energy content and carbon fraction of your diesel test fuel are 18,400 BTU/lb and 0.870, the carbon-specific net energy content of the test fuel would be 21,149 BTU/lbC. The adjustment factor in the example above would be 0.99759 (21,149/21,200). If your brake-specific CO_2 emission rate was 630.0 g/hp-hr, your official emission result would be 628.5 g/hp-hr.

Subpart G—Special Compliance Provisions

§ 1036.601 What compliance provisions apply to these engines?

(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 provisions of the Clean Air Act, and the following provisions of 40 CFR part 1068:

(1) The exemption and importation provisions of 40 CFR part 1068, subparts C and D, apply for engines subject to this part 1036, except that the hardship exemption provisions of 40 CFR 1068.245, 1068.250, and 1068.255 do not apply for motor vehicle engines.

(2) The recall provisions of 40 CFR part 1068, subpart F, apply for engines subject to this part 1036.

(b) Engines exempted from the applicable standards of 40 CFR part 86 are exempt from the standards of this part without request.

§ 1036.610 Innovative technology credits for reducing greenhouse gas emissions.

This section applies for CO_2 reductions not reflected by the specified test procedure and that result from technologies that were not in common use before 2010. For model years through 2018, we may allow you to generate emission credits consistent with the provisions of 40 CFR 86.1866–12(d).

§ 1036.615 Rankine-cycle engines 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 Rankine-cycle engines.

(a) *Hybrid powertrains.* Measure the effectiveness of the hybrid system by simulating the chassis test procedure applicable for hybrid vehicles under 40 CFR part 1037, using good engineering judgment. You need our approval before you begin testing.

(b) *Rankine-cycle engines.* Test Rankine-cycle engines according to the specified test procedures 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 and under 40 CFR part 1037, consistent with good engineering judgment.

§ 1036.620 Alternate CO_2 standards based on model year 2011 engines.

For model years 2014 through 2016, you may certify your engines to the CO_2 standards of this section instead of the CO_2 standards in § 1036.108. However, you may not certify to these alternate standards engines in a given averaging set that will be produced while you retain banked credits 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. 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 vocational engines is equal to the baseline emission rate multiplied by 0.950. The alternate CO_2 standard for tractor engines is equal to the baseline emission rate multiplied by 0.970. The in-use FEL for these engines is equal to the standard multiplied by 1.02.

(b) To be considered the baseline engine family, an engine family must meet the following criteria:

(1) It must have been certified to all applicable emission standards in model year 2011.

(2) The 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 5.00 percent of the highest rated power in the engine family being certified to the alternate standards.

(c) Include the following statement on the emission control information label: “THIS ENGINE WAS CERTIFIED TO AN ALTERNATE CO_2 STANDARD UNDER § 1036.620.”

(d) You may not generate or use 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, except that you may use up your banked credits in the same model year, but before you begin producing engines under this section.

(e) You need our approval before you may certify under this section, especially with respect to the numerical value of the alternate standards.

Subpart H—Averaging, Banking, and Trading for Certification

§ 1036.701 General provisions.

(a) You may use averaging, banking, and trading (ABT) 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 emission credit 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) [Reserved].

(c) 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.

(d) Emission credits may be exchanged only within an averaging set as specified in § 1036.740.

(e) 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.

(f) Emission credits may be used in the model year they are generated or in future model years. Emission credits may not be used for past model years, except as specified in paragraph (i) of this section.

(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. Each engine's emission control information label must include the applicable FELs.

(h) You may trade emission credits generated from any number of your engines to the engine purchasers or other parties so that they may be retired. Identify any such credits in the reports described in § 1036.725. 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.

(i) *See* § 1036.745 for provisions that allow you to have a negative credit balance for up to three consecutive model years with respect to CO_2 emissions.

§ 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. 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, calculated by dividing the total (integrated) horsepower-hour over the duty cycle by 6.3 miles for spark-ignition engines and 6.5 miles for compression-ignition engines. This represents the work performed over the mileage represented by operation over the duty cycle.

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.

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 SET duty cycle rounded to the same number of decimal places as the emission standard.

CF = the transient cycle conversion factor calculated under paragraph (b)(1) of this section.

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.

UL = the useful life for the given engine family, in miles.

(3) 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.

(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 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 1037.104.

(4) [Reserved].

(5) 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. 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 and using emission credits.

(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 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, from emission credits you have banked, or from emission credits you obtain through trading.

§ 1036.715 Banking emission credits.

(a) Banking is the retention of 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.

§ 1036.720 Trading emission credits.

(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 may be used only within 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/FCL 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 you will or will not have a negative balance for any averaging set when all emission credits are calculated at the end of the year.

(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 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.

§ 1036.730 ABT reports.

(a) If any of your engine families are certified using the ABT provisions of this subpart, you must send an end-of-year report within 90 days after the end of the model year and a final report within 270 days after the end of the model year. We may waive the requirement to send the end-of-year report, conditioned upon you sending the final report on time. We will not waive this requirement where you have a deficit for that model year or an outstanding deficit for an earlier model year.

(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 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 end-of-year and final reports 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.

(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 end-of-year report or final report as follows:

(1) You may correct any errors in your end-of-year report when you prepare the final report, as long as you send us the final report by the time it is due.

(2) If you or we determine within 270 days after the end of the model year 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 more than 270 days after the end of the model year. If you report a negative balance of emission credits, we may disallow corrections under this paragraph (f)(2).

(3) 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 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. 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.

(c) Keep a copy of the reports we require in §§ 1036.725 and 1036.730.

(d) Keep records of the engine identification 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.* Emission credits may be exchanged only within the following averaging sets:

(1) Spark-ignition engines.

(2) Compression-ignition light heavy-duty engines used in vocational vehicles.

(3) Compression-ignition medium heavy-duty engines used in vocational vehicles.

(4) Compression-ignition heavy heavy-duty engines used in vocational vehicles.

(5) Compression-ignition medium heavy-duty engines used in tractors.

(6) Compression-ignition heavy heavy-duty engines used in tractors.

(b) *Emission credits for later tiers of standards.* CO_2 credits generated relative to the standards of this part may not be used for later tiers of standards, except that credits generated before model year 2017 may be used for the tier of standards that begins in 2017.

(c) *Applying credits to prior year deficits.* Where your credit balance for the previous year is negative (*i.e.*, there was a credit deficit) you may apply only credits that are surplus after meeting your credit obligations for the current year.

(d) *Credits from hybrids and advanced technologies.* Averaging set restrictions do not apply for credits generated from hybrid engine power systems with regenerative braking, or from other advanced technologies. Such credits may also be used under 40 CFR part 1037, provided they are converted using good engineering judgment to be equivalent to credits calculated under that part.

(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, the certificate of any engine family certified to an FCL above the applicable standard for which you do not have sufficient credits is void.

(a) Your certificate for an engine family for which you do not have sufficient CO_2 credits will be 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 credits in the averaging set in any model year in which you have a deficit.

(c) You may only apply surplus credits to your deficit. You may not apply credits to a deficit from an earlier model year if the new credits are generated in a model year in which you have a net credit deficit at the end of the year for that averaging set.

(d) If you do not remedy the deficit with surplus credits within three model years, your certificate is void for that engine family. We may void the certificate based on your end-of-year report. Note that voiding a certificate applies *ab initio* (*i.e.*, retroactively). Where the net deficit is less than the total amount of negative credits originally generated by the family, we will only void the certificate with respect to enough engines 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.

§ 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. However, we may void the certificate of conformity 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.

(a) We may require you to submit a pre-certification compliance report to us for the upcoming model year or the year after the upcoming model year.

(b) 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 CO2 emission information and will verify the accuracy of the manufacturer's equivalent fuel consumption data that must be reported by NHTSA in 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 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 emissions or engine performance during emission testing or normal in-use operation. This includes, but is not limited to, parameters related to injection timing and fueling rate. You may ask us to exclude a parameter that is difficult to access if it cannot be adjusted to affect emissions without significantly degrading engine performance, or if you otherwise show us that it will not be adjusted in a way that affects emissions during in-use operation.

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 above treetop heights.

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 § 1036.701.

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 either transient or steady-state testing.

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.

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 the Manager, Heavy-Duty and Nonroad Engine Group (6405–J), U.S. Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460.

Designated Enforcement Officer means the Director, Air Enforcement Division (2242A), U.S. Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460.

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 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 to emissions at the low-hour test point.

(2) For additive deterioration factors, the difference between emissions at the end of useful life 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.

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 within an engine family. Engines within a single engine configuration differ only with respect to normal production variability or factors unrelated to emissions.

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 to not 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 1.02 and rounded to the appropriate number of decimal places.

Flexible fuel means relating to an engine designed for operation on any mixture of two or more different types of fuels.

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 pollutants and *greenhouse gases* means compounds regulated under this part based primarily on their impact on the climate. This includes CO_2, CH_4, and N_2O.

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 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.

(1) *Curb weight* has the meaning given in 40 CFR 86.1803–01, consistent with the provisions of 40 CFR 1037.140.

(2) *Basic vehicle frontal area* has the meaning given in 40 CFR 86.1803–01.

Heavy-duty engine means any engine which the engine manufacturer could reasonably expect to be used for motive power in a heavy-duty vehicle.

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.

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.

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.

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 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 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 86.1803–01.

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 means a motor vehicle engine meeting the criteria of either paragraph (1) or (2) of this definition.

(1) A motor vehicle engine for which the ultimate purchaser has never received the equitable or legal title is a *new 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.

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 hydrocarbons (NMHC) means the sum of all hydrocarbon species except methane, as measured according to 40 CFR part 1065.

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 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.

Primary intended service class has the meaning given in § 1036.140.

Rated power has the meaning given in 40 CFR part 86.

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.

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.

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, 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 engine 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 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, acronyms, and abbreviations.

The following symbols, acronyms, and abbreviations apply to this part:

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
CH4 methane
CO carbon monoxide
CO_2 carbon dioxide
DOT Department of Transportation
EPA Environmental Protection Agency
FCL Family Certification Level
FEL Family Emission Limit
g/hp-hr grams per brake horsepower-hour
GVWR gross vehicle weight rating
HC hydrocarbon
LPG liquefied petroleum gas
Mg megagrams (10^6 grams)
N_2O nitrous oxide
NARA National Archives and Records Administration
NHTSA National Highway Traffic Safety Administration
NMHC Nonmethane hydrocarbons
NO_X oxides of nitrogen (NO and NO_2)
NTE not-to-exceed
PM particulate matter
RPM revolutions per minute
SET Supplemental Emission Test (see 40 CFR 86.1362–2010)
THC total hydrocarbon
THCE total hydrocarbon equivalent
U.S.C. United States Code

§ 1036.810 Incorporation by reference.

(a) Documents listed in this section have been incorporated by reference into this part. The Director of the Federal Register approved the incorporation by reference as prescribed in 5 U.S.C. 552(a) and 1 CFR part 51. Anyone may inspect copies at the U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave., NW., Room B102, EPA West Building, Washington, DC 20460, (202) 566–1744, or 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) *ASTM material.* This paragraph (b) lists material from the American Society for Testing and Materials that we have incorporated by reference. Anyone may purchase copies of these materials from the American Society for Testing and Materials, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428 or *http://www.astm.com.*

(1) ASTM D240–09 Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter; IBR approved for § 1036.530(b).

(2) [Reserved].

§ 1036.815 What provisions apply to 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 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 § 1036.255, 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* § 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 equipment 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 equipment manufacturers.

(ii) In subpart C of this part we identify a wide range of information required to certify engines.

(iii) [Reserved].

(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 1066:

(i) In 40 CFR 1066.2 we give an overview of principles for reporting information.

(ii) [Reserved].

10. A new part 1037 is added to subchapter U 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

The regulations in this part 1037 apply for all new heavy-duty vehicles, except as provided in § 1037.5. This includes electric vehicles and vehicles fueled by conventional and alternative fuels.

§ 1037.5 Excluded vehicles.

Except for the definitions specified in § 1037.801, this part does not apply to the following vehicles:

(a) Vehicles excluded from the definition of "heavy-duty vehicle" because of vehicle weight or weight rating (such as light-duty vehicles and light-duty trucks).

(b) Medium-duty passenger vehicles.

(c) Vehicles produced in model years before 2014, unless they are certified under § 1037.150.

(d) Vehicles not meeting the definition of "motor vehicle."

§ 1037.10 How is this part organized?

This part 1037 is divided into subparts as described in this section. Note that only subparts A, B and I of this part apply for vehicles subject to the standards of § 1037.104, as described in that section.

(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) [Reserved].

(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. See § 1037.601 for a specification of 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 your vehicles for vehicles 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, including 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) Part 86 of this chapter applies for certain vehicles as specified in this part. For example, the test procedures and most of subpart S of part 86 applies for vehicles subject to § 1037.104.

(d) Other parts of this chapter apply if referenced in this part.

§ 1037.30 Submission of information.

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. It also summarizes other standards that apply under 40 CFR part 86.

(b) The regulated emissions are addressed in three groups:

(1) Exhaust emissions of NOx, 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 potentials. 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 as "greenhouse gas pollutants" because they are regulated primarily based on their impact on the climate. These standards are provided in §§ 1037.104 through 1037.106.

(3) 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, vehicles 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. These groupings apply as described in 40 CFR part 86.

(2) For greenhouse gas pollutants, vehicles are regulated in the following groups:

(i) Complete and certain incomplete vehicles at or below 14,000 pounds GVWR (see § 1037.104 for further specification). Certain provisions of 40 CFR part 86 apply for these vehicles; see § 1037.104(i) for a list of provisions in this part 1037 that also apply for these vehicles.

(ii) Tractors above 26,000 pounds GVWR.

(iii) All other vehicles. These other vehicles are referred to as "vocational" vehicles.

(3) For evaporative emissions, vehicles are regulated based on the type of fuel they use. Vehicles fueled with volatile liquid fuels and gaseous fuels are subject to evaporative emission standards, while other vehicles are not.

§ 1037.102 Exhaust emission standards for NOx, HC, PM, and CO.

See 40 CFR part 86 for the exhaust emission standards for NOx, HC, PM, and CO that apply for heavy-duty vehicles.

§ 1037.103 Evaporative emission standards.

New vehicles that run on volatile liquid fuel (such as gasoline or ethanol) or gaseous fuel (such as natural gas or LPG) must meet evaporative emission standards as specified in this section. The standards specified in paragraphs (a) and (b) of this section apply over a useful life period of 10 years or 110,000 miles, whichever comes first. Note that this section and § 1037.243 allow you to certify without testing in certain circumstances. Evaporative emission standards do not apply for diesel-fueled vehicles.

(a) *Diurnal and hot soak emissions.* Evaporative hydrocarbon emissions may not exceed the following standards when measured using the test procedures specified in § 1037.501:

(1) The sum of diurnal and hot soak measurements from the full three-day diurnal test sequence described in 40 CFR 86.1230–96 may not exceed 1.4 g for vehicles with GVWR at or below 14,000 pounds, and may not exceed 1.9 g for vehicles with GVWR above 14,000 pounds.

(2) The sum of diurnal and hot soak measurements from the two-day diurnal test sequence described in 40 CFR 86.1230–96 may not exceed 1.75 g for vehicles with GVWR at or below 14,000 pounds, and may not exceed 2.3 g for vehicles with GVWR above 14,000 pounds. The standards in this paragraph (a)(2) do not apply for vehicles that run on natural gas or LPG.

(b) *Running loss.* Running losses may not exceed 0.05 g/mile when measured using the test procedures specified in § 1037.501. The running loss standard does not apply for vehicles that run on natural gas or LPG.

(c) *Fuel spitback.* Fuel spitback emissions from vehicles with GVWR at or below 14,000 pounds may not exceed 1.0 g when measured using the test procedures specified in § 1037.501. This standard does not apply for vehicles with GVWR above 14,000 pounds or any vehicles that run on natural gas or LPG. The fuel spitback standard applies only to newly assembled vehicles.

(d) *Refueling emissions.* Complete vehicles with GVWR at or below 10,000 pounds must meet refueling emission standards as specified in 40 CFR part 86, subpart S. Incomplete heavy-duty vehicles are not subject to refueling emission standards.

(e) *Compliance demonstration for vehicles with GVWR above 26,000 pounds.* For vehicles with GVWR above 26,000 pounds, the standards described in paragraphs (a) and (b) of this section are based on an engineering analysis showing that the vehicle design adequately controls emissions. 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 (e) 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, and vehicle operating characteristics.

(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) *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.

This section applies for heavy-duty vehicles at or below 14,000 pounds GVWR. See paragraphs (f) and (g) of this section for provisions excluding certain vehicles from this section.

(a) *Fleet-average CO_2 emission standards.* Fleet-average CO_2 emission standards apply for each manufacturer as follows:

(1) First calculate a work factor, WF, for each vehicle configuration rounded to the nearest pound using the following equation:

$$WF = 0.75 \times (GVWR - \text{Curb Weight} + xwd) + 0.25 \times (GCWR - GVWR)$$

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 configuration (or submodel groups of configurations we approve) you produce using the applicable equation of this paragraph (a)(2), rounding the target value to the nearest 0.1 g/mile.

(i) For spark-ignition vehicles: CO_2 Target (g/mile) = $0.0440 \times WF + 339$

(ii) For compression-ignition vehicles and vehicles that operate without engines (such as electric vehicles and fuel cell vehicles): CO_2 Target (g/mile) = $0.0416 \times WF + 320$

(3) Calculate a production-weighted average of the target values and round it to the nearest 0.1 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 configuration or submodel (Target_i) and U.S.-directed production volume of each vehicle configuration or submodel for the given model year (Volume_i):

$$\text{Fleet-Average Standard} = \frac{\sum[\text{Target}_i \times \text{Volume}_i]}{\sum[\text{Volume}_i]}$$

(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 SEA testing and in-use testing. The in-use CO_2 standard for each vehicle is the deteriorated emission level applicable for that vehicle multiplied by 1.10 and rounded to the nearest 0.1 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. You may specify CH_4 and/or N_2O FELs and use CO_2 emission credits to show compliance with those FELs 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 relative global warming potential (RGWP): RGWP 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 40 CFR 86.1818–08(f)(2) does not apply for vehicles subject to the standards of this section. Calculate credits using the following equation:

$$CO_2 \text{ Credits Needed (Mg)} = [(\text{Std} - \text{FEL}) \times (\text{U.S.-directed production volume}) \times (\text{Useful Life})] \times (\text{RGWP}) \div 1{,}000{,}000$$

(d) *Compliance provisions.* Except as specified in this paragraph (d) or elsewhere in this section, the provisions of 40 CFR part 86, describing compliance with the greenhouse gas standards of subpart S of that part apply with respect to the standards of paragraphs (a) through (c) of this section.

(1) The CO_2 standards of this section apply with respect to CO_2 emissions instead of carbon-related exhaust emissions (CREE).

(2) Vehicles subject to the standards of this section are included in a single greenhouse gas averaging set separate from any averaging sets otherwise included in 40 CFR part 86.

(3) Special credit and incentive provisions related to flexible-fuel vehicles and air conditioning in 40 CFR part 86 do not apply for vehicles subject to the standards of this section.

(4) The CO_2, N_2O, and CH_4 standards apply for a weighted average of the city (55%) and highway (45%) test cycle results as specified for light-duty vehicles in 40 CFR part 86, subpart S. Note that this differs from the way the criteria pollutant standards apply for heavy-duty vehicles.

(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 actual 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 the "vehicle lifetime miles" specified in subpart S of 40 CFR part 86.

(7) Credits generated from hybrid vehicles with regenerative braking or vehicles with advanced technologies may be used to show compliance with any standards of this part or 40 CFR part 1036, provided they are converted using good engineering judgment to be equivalent to credits calculated under that part.

(8) The provisions of 40 CFR 86.1818 do not apply.

(e) *Useful life.* The useful life values for the standards of this section are those that apply for criteria pollutants under 40 CFR part 86.

(f) *Rolling chassis exclusion.* The standards of this section apply for each vehicle that is in a complete or cab-complete configuration when first sold as a vehicle. The standards of this section do not apply for other vehicles. The vehicle standards and requirements of § 1037.105 apply for the excluded vehicles. The GHG standards of 40 CFR part 1036 also apply for engines used in these excluded vehicles. If you are not the engine manufacturer, you must notify the engine manufacturers that their engines are subject to 40 CFR part 1036 because you intend to use their engines in your excluded vehicles.

(g) *Low-volume exclusion.* You may exclude a limited number of vehicles from the standards of this section, as specified in this paragraph (g). The number of excluded vehicles may not exceed 2,000 in any model year, unless your total production of vehicles in this category for that model year is greater than 100,000 vehicles and your excluded vehicles are not more than 2.000 percent of your actual U.S.-directed production volume in this category for any model year. For example, a vehicle manufacturer producing 200,000 vehicles in a given model year could exclude up to 4,000 vehicles under this paragraph (g). The vehicle standards and requirements of § 1037.105 apply for the excluded vehicles. The GHG standards of 40 CFR part 1036 also apply for engines used in these excluded vehicles. We may require you to submit a pre-production plan describing how you will use the provisions of this paragraph (g). If you are not the engine manufacturer, you must notify the engine manufacturers that their engines are subject to 40 CFR part 1036 because you intend to use their engines in your excluded vehicles.

(h) *Cab-complete vehicles.* The provisions of this section apply to cab-complete vehicles in the same manner as they apply to complete vehicles, except as specified in this paragraph (h). Calculate the target value based on the same work factor value that applies for the most similar complete vehicle you certify. Test these cab-complete vehicles using the same test weight and other dynamometer settings that apply for the complete vehicle from which you used the work factor value. For certification, you may submit the test data from that similar vehicle instead of performing the test on the cab-complete vehicle.

(i) *Applicability of part 1037 provisions.* Except as specified in this section, the requirements of this part do not apply to vehicles certified to the standards of this section. The following provisions are the only provisions of this part that apply to vehicles certified under this section:

(1) The provisions of this section.

(2) The evaporative emission standards in § 1037.103.

(3) The air conditioning standards in § 1037.115.

(3) The curb weight provisions of § 1037.140.

(4) The interim provisions of § 1037.150.

(5) The reporting provisions of § 1037.755.

(6) The definitions of § 1037.801.

§ 1037.105 Exhaust emission standards for CO_2, CH_4, and N_2O for vocational vehicles.

(a) The standards of this section apply for the following vehicles:

(1) Vehicles above 14,000 pounds GVWR but at or below 26,000 pounds GVWR.

(2) Vehicles above 26,000 pounds GVWR that are not tractors.

(3) Vehicles at or below 14,000 pounds GVWR that are excluded from the standards in § 1037.104 under § 1037.104(f) or (g).

(b) The CO_2 standards of this section are given in Table 1 to this section. The provisions of § 1037.241 specify how to comply with these standards.

Table 1 to § 1037.105—CO_2 Standards for Vocational Vehicles

GVWR (pounds)	CO_2 Standard (g/ton-mile) for Model Years 2014-2016	CO_2 Standard (g/ton-mile) for Model Year 2017 and later
GVWR ≤ 19,500	358	344
19,500 < GVWR ≤ 33,000	212	204
33,000 < GVWR	109	107

(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 under the ABT program, as described in subpart H of this part. This requires that you specify a Family Emission Limit (FEL) for each pollutant you include in the ABT program for each vehicle family. 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 family instead of the standards specified in paragraph (b) of this section.

(e) The useful life values for the standards of this section are those that apply for criteria pollutants under 40 CFR part 86.

(f) See § 1037.630 for provisions that exempt certain vehicles used in offroad operation from the standards of this section.

§ 1037.106 Exhaust emission standards for CO_2, CH_4, and N_2O for tractors above 26,000 pounds GVWR.

The following CO_2 standards apply for tractors above 26,000 pounds GVWR:

Table 1 to § 1037.106—CO_2 Standards for Tractors above 26,000 Pounds GVWR

GVWR (pounds)	Sub-category	CO_2 Standard (g/ton-mile) for Model Years 2014-2016	CO_2 Standard (g/ton-mile) for Model Year 2017 and later
26,000 < GVWR ≤ 33,000	Low-Roof and Mid-Roof (all cab styles)	104	103
	High-Roof (all cab styles)	118	116
GVWR > 33,000	Low-Roof Day Cab	79	78
	Low-Roof Sleeper Cab	65	64
	Mid-Roof Day Cab	79	78
	Mid-Roof Sleeper Cab	70	69
	High-Roof Day Cab	87	86
	High-Roof Sleeper Cab	73	71

(b) 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.

(c) You may generate or use emission credits under the ABT program, as described in subpart H of this part. This requires that you specify a Family Emission Limit (FEL) for each pollutant you include in the ABT program for each vehicle family. 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 family instead of the standards specified in paragraph (a) of this section.

(d) The useful life values for the standards of this section are those that apply to the engine or vehicle for criteria pollutants under 40 CFR part 86.

(e) *See* § 1037.630 for provisions that exempt certain vehicles use in offroad operation from the standards of this section.

§ 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 part 86 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 are deemed to not 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) *Air conditioning leakage.* Loss of refrigerant from your air conditioning systems may not exceed 1.50 percent per year. Calculate the absolute leakage rate in g/year as specified in 40 CFR 86.166–12. Calculate the percent leakage rate as: [absolute leakage rate (g/yr)] ÷ [total refrigerant capacity (g)] × 100. *See* § 1037.150 for vocational vehicles.

(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, adjust your leakage rate by multiplying it by the global warming potential of your refrigerant and dividing the product by 124 (which is the global warming potential of HFC–134a). Determine global warming potentials consistent with 40 CFR 86.1866–12.

§ 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 may keep it from meeting these requirements.

(b) *Warranty period.* Your emission-related warranty with respect to greenhouse gas and evaporative emissions must be valid for at least as long as the minimum periods specified in 40 CFR part 86 for the engine used in the vehicle. 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 published warranty you offer with or without charge for the vehicle. Similarly, the emission-related warranty for any component may not be shorter than any published warranty you offer with or without charge for that component. The warranty period begins when the vehicle is placed into service.

(c) *Components covered.* The emission-related warranty covers vehicle speed limiters, idle shutdown systems, fairings, hybrid system components, and all components whose failure would increase a vehicle's evaporative emissions. 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.

(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. 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 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.

§ 1037.135 Labeling.

(a) Assign each vehicle a unique identification number and permanently affix, engrave, or stamp it on the vehicle in a legible way. For example, 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 (and subfamily, where applicable).

(4) State the regulatory sub-category 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 keep a record of the vehicle-manufacture dates and provide it to us upon request.

(6) State the FELs to which the vehicles are certified if certification depends on the ABT provisions of subpart H of this part.

(7) Identify the emission control system. Use terms and abbreviations as described in 40 CFR 1068.45 or other applicable conventions.

(8) Identify any requirements for fuel and lubricants that do not involve fuel-sulfur levels.

(9) State: "THIS VEHICLE COMPLIES WITH U.S. EPA REGULATIONS FOR [MODEL YEAR] HEAVY-DUTY-VEHICLES."

(10) Include the following statement, if applicable: "THIS VEHICLE IS DESIGNED TO COMPLY WITH EVAPORATIVE EMISSION STANDARDS WITH UP TO x 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. However, if you provide additional information on the label, you may not omit any required information on the basis that a label containing all of the required information will not fit on the vehicle.

(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 Curb weight and roof height.

(a) Where applicable, a vehicle's curb weight and roof height are determined from nominal design specifications, as provided in this section. Round the weight to the nearest pound and height to the nearest inch.

(b) The nominal design specifications must be within the range of the actual weights and roof heights of production vehicles considering normal production variability. 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.

(c) If your vehicle is equipped with an adjustable roof fairing, measure the roof height with the fairing in its lowest setting.

§ 1037.141 Determining aerodynamic bins for tractors.

Demonstrating compliance with the emission standards in § 1037.106 depends on computer modeling as described in § 1037.520, which in turn depends on establishing a vehicle's drag coefficient. This section differentiates vehicles into apparent bin categories based on vehicle design characteristics that affect aerodynamic drag. These apparent bin categories are used to verify drag coefficients determined under § 1037.520. Each of these apparent bin categories is associated with a range of expected drag coefficient values. Section 1037.520 describes how to establish input values for emission modeling based on the empirical value for a specific vehicle and how that value relates to the apparent bin category as described in this section. Determine the apparent bin category for your vehicle as follows:

(a) Your vehicle is in the "Classic" category if either of the following is true:

(1) It includes an external air cleaner and/or a B-pillar exhaust stack.

(2) It includes two or more of the following: Bug deflectors, custom sunshades, external horns, external lights, or more than two external mirrors that are not streamlined (*i.e.,* aerodynamically efficient).

(b) Your vehicle is in the "Conventional" category if it does not meet the criteria specified for any other apparent bin category.

(c) Your vehicle is in the "Smartway" category if it does not meet the criteria for "Advanced Smartway" or "Advanced Smartway II" and either of the following is true:

(1) The vehicle has all of the following:

(i) A fully enclosed roof fairing.

(ii) Side extending gap reducers.

(iii) Fuel tank fairings or aerodynamic fuel tanks.

(iv) Streamlined grill, hood, mirrors, and bumper.

(2) The vehicle has a low-roof or mid-roof design and has all the features identified in paragraph (c)(1) of this section except for the roof fairing.

(d) Your vehicle is in the "Advanced Smartway" category if it meets the criteria of either paragraph (c)(1) or (2) of this section but not the criteria for "Advanced Smartway II", and the vehicle incorporates at least two of the following features:

(1) Underbody airflow treatment.

(2) Down exhaust.

(3) Lowered ride height.

(e) Your vehicle is in the "Advanced Smartway II" category if it meets the criteria of either paragraph (c)(1) or (2) of this section; it meets all the criteria of paragraph (d)(1) through (3) of this section; and it incorporates aerodynamic improvements not in commercial use in 2010.

§ 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. To do so for any vehicles other than electric vehicles, you must certify your entire U.S.-directed production volume within the averaging set to these standards. Calculate credits relative to the standard that would apply in model year 2014 using the equations in subpart H of this part. 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.

(b) *Phase-in provisions.* Each manufacturer must choose one of the following options for phasing in the standards of § 1037.104:

(1) To implement the phase-in under this paragraph (b)(1), the standards in § 1037.104 apply as specified for model year 2018, with compliance for those vehicles in model years 2014 through 2017 based on the CO_2 target values specified in the following table:

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Table 1 to § 1037.150

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
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

To implement the phase-in under this paragraph (b)(2), the standards in § 1037.104 apply as specified for model year 2019, with compliance for those vehicles in model years 2014 through 2018 based on the CO_2 target values specified in the following table:

BILLING CODE 6560–50–C

Table 2 to § 1037.150

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
2014 Compression-Ignition	[0.0478 × (WF)] + 368
2015 Compression-Ignition	[0.0474 × (WF)] + 366
2016-2018 Compression-Ignition	[0.0440 × (WF)] + 339

(c) *Provisions for small manufacturers.* Manufacturers meeting the small business criteria specified in 13 CFR 121.201 for "Heavy Duty Truck Manufacturing" are not subject to the greenhouse gas standards of §§ 1037.104 through 1037.106, as specified in this paragraph (c). Qualifying manufacturers must notify the Designated Compliance Officer 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.

(d) *Air conditioning leakage for vocational vehicles.* The air conditioning leakage standard of § 1037.115 does not apply for vocational vehicles.

(e) *Approval of alternate methods to determine drag coefficients.* For model years before 2017, you must obtain preliminary approval before using any methods other than coastdown testing to determine drag coefficients under § 1037.520.

(f) *Model year 2014 N_2O standards.* In model year 2014, manufacturers may show compliance with the N_2O standards using an engineering analysis.

(g) *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 such electric vehicles.

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 December 31 of the model year for which it is issued. 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 require you to deliver your test vehicles to a facility we designate for our testing. Alternatively, you may choose to deliver another vehicle that is identical in all material respects to the test vehicle. Where certification is based on testing components such as tires, we may require you to deliver test components to a facility we designate for our testing.

§ 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. Note that references to testing and emission-data vehicles refer to testing vehicles to measure aerodynamic drag, assess hybrid vehicle performance, and/or measure evaporative emissions.

(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 vehicles are designed to operate (for example, ultra low-sulfur diesel fuel). List each distinguishable vehicle configuration in the vehicle family.

(b) Explain how the emission control system operates. As applicable, describe in detail all system components for controlling greenhouse gas and evaporative 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.

(c) [Reserved]

(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).

(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 levels. Explain why you selected the method of service accumulation. Describe any scheduled maintenance you did.

(g) 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 you will give to the ultimate purchaser of each new vehicle (*see* § 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, identify the FELs for each subfamily.

(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.

(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) Present evaporative test data to show your vehicles meet the evaporative emission standards we specify in subpart B of this part, if applicable. Report all test results, including test results from invalid tests or from any other tests, whether or not they were conducted according to the test procedures of subpart F of this part. 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 86.

(o) Report modeling results for each subfamily. Include modeling inputs and detailed descriptions of how they were derived.

(p) Describe all adjustable operating parameters (*see* § 1037.115(e)), 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. Include a justification for the estimated production volumes if they are substantially different than actual production volumes in earlier years for similar vehicle models.

(t) Include the information required by other subparts of this part. For example, include the information required by § 1037.725 if you participate in the ABT program.

(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.

§ 1037.220 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, 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. 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 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.

(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). If we approve a changed FEL after the start of production, you must include the new FEL on the emission control information label for all vehicles produced after the change. 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 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 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 family 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 family 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.

§ 1037.230 Vehicle families.

(a) For purposes of certifying your vehicles to greenhouse gas standards, divide your product line into families of vehicles that have similar basic structures and are subject to the same standards. Your vehicle family is limited to a single model year. Group vehicles in the same vehicle family if they are the same in all the following aspects:

(1) The regulatory sub-category, as follows:

(i) Vocational vehicles at or below 19,500 pounds GVWR.

(ii) Vocational vehicles above 19,500 pounds GVWR but at or below 33,000 pounds GVWR.

(iii) Vocational vehicles above 33,000 pounds GVWR.

(iv) Low-roof and mid-roof day cab tractors above 26,000 pounds GVWR but at or below 33,000 pounds GVWR.

(v) High-roof tractors above 26,000 pounds GVWR but at or below 33,000 pounds GVWR.

(vi) Low-roof day cab tractors above 33,000 pounds GVWR.

(vii) Low-roof sleeper cab tractors above 33,000 pounds GVWR.

(viii) Mid-roof day cab tractors above 33,000 pounds GVWR.

(ix) Mid-roof sleeper cab tractors above 33,000 pounds GVWR.

(x) High-roof day cab tractors above 33,000 pounds GVWR.

(xi) High-roof sleeper cab tractors above 33,000 pounds GVWR.

(2) Vehicle width (as measured from hub to hub on the front axle).

(3) Basic design of the vehicle passenger and engine compartments. For purposes of this criterion, consider only those features from the B-pillar forward.

(4) Whether or they are certified using the provisions of this part for hybrid vehicles or other advanced technologies.

(b) Subdivide your greenhouse gas vehicle families into subfamilies that include vehicles from identical bins for the aerodynamic drag coefficient for each modeling input, as specified in § 1037.520(b). For example, all vehicles within a tractor vehicle family would be included in the same subfamily if they are all in the "SmartWay" aerodynamic bin and in the "Automatic Engine Shut-Off Only" bin, none of them include weight reduction or vehicle speed limiters, and they all use the same tires.

(c) For a vehicle model that straddles a roof-height division, you may include all the vehicles in the same vehicle family if you certify the vehicle family to the more stringent standards.

(d) Divide your vehicles that are subject to evaporative emission standards into groups of vehicles with similar physical features expected to affect evaporative emissions. Group vehicles in the same evaporative emission family if they are the same in all the following aspects, unless we approve a better way of grouping vehicles into families that have similar emission control characteristics:

(1) Method of vapor storage, including the number of vapor storage devices, the working material, and the total working capacity of vapor storage (as determined under 40 CFR 86.1232–96(h)(1)(iv)). You may consider the working capacity to be the same if the values differ by 20 grams or less.

(2) Method of purging stored vapors.

(3) Material for liquid fuel hose.

§ 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 emission standards in § 1037.105 or § 1037.106 if all vehicle configurations in that family have modeled CO_2 emission rates (as specified in subpart F of this part) at or below the applicable standards. *See* 40 CFR part 86, subpart S, for showing compliance with the standards of § 1037.104. Note that your 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.

(b) Your vehicle family is deemed not to comply if any vehicle configuration in that family has a modeled CO_2 emission rate that is above its FEL.

(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 (DFs) consistent with good engineering judgment. For example, you may need to apply a DF to address deterioration of battery performance for a hybrid-electric vehicle.

§ 1037.243 Demonstrating compliance with evaporative emission standards.

(a) For purposes of certification, your evaporative emission family is considered in compliance with the evaporative emission standards in subpart B of this part if you do either of the following:

(1) You have test results showing emission levels at or below the standards in § 1037.103.

(2) For vehicles above 26,000 pounds GVWR, you prepare an engineering analysis showing that your vehicles in the family will comply with applicable standards throughout the useful life.

(b) Your evaporative emission family is deemed not to comply if any vehicle representing the family has test results showing emission levels above any of the standards in § 1037.103, with or without deterioration factors. For vehicles above 26,000 pounds GVWR, 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.

(c) To compare emission levels with emission standards, apply deterioration factors to the measured emission levels. Establish an additive deterioration factor for the vehicle family, as described in 40 CFR 86.007–23(b).

(1) For vehicles at or below 26,000 pounds GVWR, establish the deterioration factor based on testing before and after service accumulation. Collect emission data using measurements to one more decimal place than the applicable standard. Use good engineering judgment to perform service accumulation in a way that incorporates the effects of ambient conditions and engine and vehicle operation to ensure that emission measurements represent actual degradation of emission controls from in-use vehicles over the useful life.

(2) For vehicles above 26,000 pounds GVWR, establish the deterioration factor based on an engineering analysis that takes into account the expected aging from in-use vehicles. Your analysis must take into account your testing to establish deterioration factors under paragraph (c)(1) of this section.

(d) You may ask us to approve deterioration factors for a vehicle family based on emission measurements from similar highway vehicles if you have already given us these data for certifying the other vehicles in the same or earlier model years. Use good engineering judgment to decide whether the two vehicles are similar. We will approve your request if you show us that the emission measurements from other vehicles reasonably represent in-use deterioration for the vehicle family for which you have not yet determined deterioration factors.

(e) 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.

§ 1037.250 Reporting and recordkeeping.

(a) Within 45 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. Report the volumes by vehicle configuration, and identify the transmission, axle ratio, and engine in addition to subfamily identifiers. Small manufacturers may omit this requirement.

(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, 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.

(c) Keep data from routine emission tests (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.

§ 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).

(3) Render any test data inaccurate.

(4) Deny us from completing authorized activities despite our presenting a warrant or court order (*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.

(d) We may void your certificate if you do not keep the records we require or do not give us information as required under this part or the Act.

(e) We may void your certificate if we find that you intentionally submitted false or incomplete information.

(f) If we deny your application or suspend, revoke, or void your certificate, you may ask for a hearing (*see* § 1037.820).

Subpart D—[Reserved]

Subpart E—In-Use Testing

§ 1037.401 General provisions.

We may perform in-use testing of any vehicle subject to the standards of this part.

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) Use the equipment and procedures specified in 40 CFR part 86, subpart M, to determine whether vehicles meet the diurnal, running loss, hot soak, and spitback standards specified in § 1037.103. For certification vehicles only, you may ask us to approve subtraction of nonfuel emissions (such as from off-gassing plastic components) from your measured test results. In your request, describe the sources of nonfuel emissions and estimate the decay rate. Quantify the nonfuel emissions based on separate testing.

(b) Where emission testing is required, use the equipment and procedures in 40 CFR part 1066 to determine whether your vehicles meet the duty-cycle emission standards in subpart B of this part. Measure the emissions of all the exhaust constituents subject to emission standards as specified in 40 CFR part 1066. Use the applicable duty cycles specified in § 1037.510.

(c) [Reserved]

(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 the 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 to the extent we allow them under 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 the specification of this paragraph (g) whenever we specify use of standard trailers. A tolerance of ± 2 inches applies for all trailer dimensions. Manufacturers may test with longer trailers. For coastdown testing, load trailers as necessary to reach test weight.

(1) The standard trailer for high-roof tractors is a two-axle dry van box trailer with dimensions of 53.0 feet long, by 102 inches wide, by 162 inches high. The standard trailer has a minimized trailer gap (maximum of 45 inches) and does not include any aerodynamic features such as side fairings, boat tails, or gap reducers.

(2) The standard trailer for mid-roof tractors is a two-axle tanker trailer with dimensions of 40.0 feet long by 124 inches high, and having a 7200 ± 7 gallon tank capacity. The standard trailer does not include any aerodynamic features such as side fairings.

(3) The standard trailer for low-roof tractors is a two-axle flat bed trailer with dimensions of 48.0 feet long and 102 inches wide. The standard trailer does not include any aerodynamic features such as side fairings. It includes a payload of dense material (such as steel plate) covered completely with one or more tarps. For aerodynamic modeling, use an amount equivalent to a standard payload of 25,000 pounds for Class 7 and 38,000 pounds for Class 8.

§ 1037.510 Duty-cycle testing.

This section applies where exhaust emission testing is required, such as when applying the provisions of § 1037.610.

(a) Where applicable, measure emissions by testing the vehicle on a dynamometer with the applicable test cycles. Each test cycle consists of a series of speed commands over time: Variable speeds for the transient test and constant speed for the cruise tests. None of these cycles include vehicle starting or warmup; each test cycle begins with a running, warmed-up vehicle. Start sampling emissions at the start of each cycle. The transient cycle is specified in Appendix I to this part. The 55 mph and 65 mph Cruise cycles are 300 second cycles with constant vehicle speeds of 55.0 mph and 65.0 mph, respectively. The tolerance around these speed setpoints is ±1.0 mph.

(b) Calculate the official emission result from the following weighting factors:

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Table 1 to § 1037.510—Weighting Factors for Duty Cycles

	Transient	55 mph Cruise	65 mph Cruise	PTO
Vocational	42%	21%	37%	0%
Vocational, with PTO	30%	15%	27%	28%
Day Cabs	19%	17%	64%	0%
Sleeper Cabs	5%	9%	86%	0%

(c) 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 part 1066. If the speeds do not conform to these criteria, the test is not valid and must be repeated.

(d) Run test cycles as specified in 40 CFR part 86. For cruise cycle testing of vehicles equipped with cruise control, use the vehicle's cruise control to control the vehicle speed.

§ 1037.520 Modeling CO_2 emissions to show compliance.

This section describes how to use the GEM computer model (incorporated by reference in § 1037.810) to show compliance with the CO_2 standards of §§ 1037.105 and 1037.106. Use good engineering judgment when demonstrating compliance using the GEM model.

(a) *General modeling provisions.* To run the GEM model, enter all applicable inputs as specified by the model. All seven of the following inputs apply for sleeper cab tractors, while some do not apply for other regulatory subcategories:

(1) Regulatory class (such as "Class 8 Combination—Sleeper Cab—High Roof").

(2) Coefficient of aerodynamic drag, as described in paragraph (b) of this section. Leave this field blank for vocational vehicles.

(3) Steer tire rolling resistance, as described in paragraph (c) of this section.

(4) Drive tire rolling resistance, as described in paragraph (c) of this section.

(5) Vehicle speed limit, as described in paragraph (d) of this section. Leave this field blank for vocational vehicles.

(6) Vehicle weight reduction, as described in paragraph (e) of this section. Leave this field blank for vocational vehicles.

(7) Extended idle reduction credit, as described in paragraph (f) of this section. Leave this field blank for vehicles other than Class 8 sleeper cabs.

(b) *Coefficient of aerodynamic drag.* Determine the appropriate drag coefficient as follows:

(1) Use the recommended method or an alternate method to establish a value for the vehicle's drag coefficient, rounded to two decimal places as follows:

(i) *Recommended method.* Perform coastdown testing as described in this paragraph (b)(1)(i) to establish the drag coefficient. Use the procedures specified in 40 CFR part 1066, subpart C, with a standard trailer.

(A) Calculate the drag coefficient, C_D, from the following equation:

$$C_D = \frac{D}{2\rho A}$$

Where:

D = a coefficient derived from the coastdown procedures in 40 CFR part 1066, as described in paragraph (b)(1)(i)(B) of this section.

ρ = standard air density. Use ρ = 1.167 kg/m³.

A = standard frontal area, in m², as shown in the following table:

Table 1 to § 1037.520—Standard Frontal Area

Class 7		Class 8				
Day Cab		Day Cab		Sleeper Cab		
Low-Roof and Mid-Roof	High-Roof	Low-Roof and Mid-Roof	High-Roof	Low-Roof	Mid-Roof	High-Roof
6.0	9.8	6.0	9.8	6.0	7.7	9.8

(B) Determine the value of D analytically from the data collected during coastdown testing as specified in 40 CFR 1066.210, based on one of the following equations:

$$-M_e \frac{dS}{dt} = A_m + DS_r^2 + ES_r^2 Y^2$$

or

$$-M_e \frac{dS}{dt} = A_m + DS_r^2$$

(ii) *Alternate methods.* You may determine a drag coefficient using an alternate method, consistent with good engineering judgment, based on wind tunnel testing, computational fluid dynamic modeling, or constant-speed road load testing. *See* 40 CFR 1068.5 for provisions describing how we may evaluate your engineering judgment. Use (or assume) a standard trailer for tractor testing and modeling.

(2) Determine the bin category for your vehicle based on the drag coefficient from paragraph (b)(1) of this section as shown in the following table:

Table 2 to § 1037.510—Bin Categories Corresponding to Drag Coefficients

Bin Category	Class 7		Class 8				
	Day Cab		Day Cab		Sleeper Cab		
	Low-Roof and Mid-Roof	High-Roof	Low-Roof and Mid-Roof	High-Roof	Low-Roof	Mid-Roof	High-Roof
Classic	≥0.83	≥0.73	≥0.83	≥0.73	≥0.83	≥0.78	≥0.73
Conventional	0.78-0.82	0.63-0.72	0.78-0.82	0.63-0.72	0.78-0.82	0.73-0.77	0.63-0.72
SmartWay	0.73-0.77	0.58-0.62	0.73-0.77	0.58-0.62	0.73-0.77	0.68-0.72	0.58-0.62
Advanced SmartWay	0.68-0.72	0.53-0.57	0.68-0.72	0.53-0.57	0.68-0.72	0.63-0.67	0.53-0.57
Advanced SmartWay II	≤0.67	≤0.52	≤0.67	≤0.52	≤0.67	≤0.62	≤0.52

(3) Except as specified in paragraph (b)(4) of this section, determine the modeling input for drag coefficient from the following table, based on the vehicle's bin category as described in paragraph (b)(2) of this section:

Table 3 to § 1037.510—**Aerodynamic Input to GEM (C_D)**

Bin Category	Class 7		Class 8				
	Day Cab		Day Cab		Sleeper Cab		
	Low-Roof and Mid-Roof	High-Roof	Low-Roof and Mid-Roof	High-Roof	Low-Roof	Mid-Roof	High-Roof
Classic	0.85	0.75	0.85	0.75	0.85	0.80	0.75
Conventional	0.80	0.68	0.80	0.68	0.80	0.75	0.68
SmartWay	0.75	0.60	0.75	0.60	0.75	0.70	0.60
Advanced SmartWay	0.70	0.55	0.70	0.55	0.70	0.65	0.55
Advanced SmartWay II	0.65	0.50	0.65	0.50	0.65	0.60	0.50

(4) If your drag coefficient from paragraph (b)(1) of this section is below the range of drag coefficient values specified for the applicable bin category in § 1037.141, you may use the drag coefficient determined in paragraph (b)(3) of this section only with our approval. We will approve your request if you demonstrate that you developed your drag coefficient consistent with good engineering judgment. If we deny your request, you must use the drag coefficient corresponding to your vehicle's apparent bin category.

(c) *Steer and drive tire rolling resistance.* Measure tire rolling resistance in kg per metric ton as specified in ISO test method 28580:2009 (incorporated by reference in § 1037.810). For each tire design (including size), measure rolling resistance of at least three different tires of that specific design and perform the test three times for each tire (for a total of at least nine tests per tire design). Use the arithmetic mean of these results. If you obtain your test results from the tire manufacturer or another third party, you must obtain a signed statement from them verifying the tests were conducted according to the requirements of this part. Such statements are deemed to be submissions to EPA.

(d) *Vehicle speed limit.* If the vehicles will be equipped with a tamper-proof vehicle speed limiter, input the maximum vehicle speed to which the vehicle will be limited, in miles per hour. Otherwise leave this field blank. Use good engineering judgment to ensure the limiter is tamper proof. We may require you to obtain preliminary approval for your designs.

(e) *Vehicle weight reduction.* Vehicle weight reduction inputs are specified relative to dual-wide tires with conventional steel wheels. For purposes of this paragraph (e), a light-weight aluminum wheel is one that weighs at least 21 lb less than a comparable conventional steel wheel, and a high-strength steel wheel is one that weighs at least 8 lb less than a comparable conventional steel wheel. The inputs are listed in Table 4 to this section. For example, a tractor with aluminum steer wheels and eight (4 × 2) dual-wide aluminum drive wheels would have an input of 210 lb (2 × 21 + 8 × 21).

Table 4 to § 1037.520—Tire-Related Weight Reductions

Weight Reduction Technology		Weight Reduction (lb per tire or 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

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(f) *Extended idle reduction credit.* If your vehicle is equipped with idle reduction technology that will automatically shut off the main engine after 300 seconds or less, use 5 g/ton-mile as the input. Otherwise leave this field blank.

§ 1037.525 Special procedures for testing hybrid vehicles with power take-off.

This section describes the procedure for quantifying the reduction in greenhouse gas emissions as a result of running power take-off (PTO) devices with a hybrid powertrain. You may ask us to modify the provisions of this section to allow testing non-electric hybrid vehicles, consistent with good engineering judgment.

(a) Select two vehicles for testing as follows:

(1) Select a vehicle with a hybrid powertrain 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 § 1037.610.

(b) Measure PTO emissions from the conventional vehicle as follows:

(1) Start the engine.

(2) Operate the vehicle over the PTO duty cycle(s) specified in Appendix II of this part. If there is only one PTO circuit, use duty cycle #1; if there are two PTO circuits, use both specified duty cycles. Collect CO_2 emissions during operation over the specified duty cycle(s).

(3) Use the provisions of 40 CFR part 1066 to collect and measure emissions. Calculate emission rates in grams per test without rounding.

(4) Continue testing over the three vehicle drive cycles, as otherwise required by this part.

(5) Calculate combined cycle-weighted emissions of the four cycles as specified in paragraph (d) of this section.

(c) Measure PTO emissions from the hybrid vehicle as follows:

(1) Prepare the vehicle for testing by operating it as needed to stabilize the battery at a full state of charge.

(2) Turn the vehicle "on" such that the PTO system is functional, whether it draws power from the engine or a battery.

(3) Operate the vehicle over the PTO cycle(s) and measure emissions as described in paragraphs (b)(2) and (3) of this section. Use good engineering judgment to minimize the variability in testing between the two types of vehicles.

(4) Continue testing over the three vehicle drive cycles, as otherwise required by this part.

(5) Calculate combined cycle-weighted emissions of the four cycles as specified in paragraph (d) of this section.

(d) Calculate combined cycle-weighted emissions of the four cycles for vocational vehicles as follows:

$$Emissions\,(g/ton-mile)=\frac{1}{payload}\times\frac{0.28\times m_1+0.30\times m_2+0.15\times m_3+0.27\times m_4}{0.30\times 2.84\,miles+0.15\times 4.58\,miles+0.27\times 5.41\,miles}$$

Where:

payload = the standard payload, in tons, as specified in § 1037.705.

m_1 = grams of CO_2 emitted over the PTO test cycle.

m_2 = grams of CO_2 emitted over the transient test cycle.

m_3 = grams of CO_2 emitted over the 55 mph cruise test cycle.

m_4 = grams of CO_2 emitted over the 65 mph cruise test cycle.

(e) Follow the provisions of § 1037.610 to calculate improvement factors and benefits for advanced technologies.

Subpart G—Special Compliance Provisions

§ 1037.601 What compliance provisions apply to these vehicles?

(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 the Clean Air Act, and the following provisions of 40 CFR part 1068:

(1) The exemption and importation provisions of 40 CFR part 1068, subparts C and D, apply for vehicles subject to this part 1037, except that the hardship exemption provisions of 40 CFR 1068.245, 1068.250, and 1068.255 do not apply for motor vehicles.

(2) The recall provisions of 40 CFR part 1068, subpart F, apply for vehicles subject to this part 1037. The recall provisions of 40 CFR part 85, subpart S do not apply.

(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 86.1854–12 apply for vehicles subject to the requirements of this part.

(d) Except as specifically allowed by this part, it is a violation of section 203(a)(1) of the Clean Air Act (42 U.S.C. 7522(a)(1)) to introduce into U.S. commerce a tractor containing an engine not certified for use in tractors or to introduce into U.S. commerce a vocational vehicle containing an engine not certified for use in vocational vehicles. This prohibition generally applies to the vehicle manufacturer.

§ 1037.610 Hybrid vehicles and other advanced technologies.

(a) This section applies for 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.

(b) Generate advanced technology emission credits for hybrid vehicles that include regenerative braking (or the equivalent) and energy storage systems and vehicles equipped with Rankine-cycle engines as follows:

(1) Measure the effectiveness of the hybrid system by chassis testing a vehicle equipped with the hybrid system and an equivalent conventional vehicle. For purposes of this paragraph (b), a conventional vehicle is considered to be equivalent if it has the same footprint, intended service class, aerodynamic drag, and other factors not directly related to the hybrid powertrain. 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 hybrid 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 × (Modeling Result B)

(iii) Emission Rates A and B are the g/ton-mile CO_2 emission rates of the conventional and hybrid vehicles, respectively, as measured under the test procedures specified in this section. Modeling Result B is the g/ton-mile CO_2 emission rate resulting from emission modeling of the hybrid vehicle as specified in § 1037.520.

(3) 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* § 1037.525 for special testing provisions related to hybrid vehicles equipped with 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) Credits generated under this section may be used outside of the averaging set in which they were generated, or you may convert the credits into engine-based credits for use under 40 CFR part 1036, consistent with good engineering judgment.

§ 1037.611 Vehicles with innovative technologies.

This section 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 and emission models. We may allow you to generate emission credits for model years through 2018 consistent with the provisions of 40 CFR 86.1866–12(d).

§ 1037.620 Shipment of incomplete vehicles to secondary vehicle manufacturers.

This section specifies how manufacturers may introduce partially complete vehicles into U.S. commerce.

(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. Note that delegated assembly provisions may apply.

(2) *Vehicles meeting the definition of "tractor" intended for vocational use.* A manufacturer may introduce into U.S. commerce a partially complete vehicle meeting the definition of "tractor" that is covered by a certificate of conformity for vocational vehicles only as allowed by paragraph (b) of this section.

(3) *Other vocational vehicles.* Manufacturers may introduce partially complete vocational vehicles (not meeting the definition of "tractor") 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.

(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 (c) of this section.

(b) Manufacturers introducing partially complete vehicles into U.S. commerce under paragraph (a)(2) of this section must have a written request for such vehicles from the manufacturer that will complete assembly of the vehicle. The written request must include a statement that the manufacturer completing assembly is aware that the vehicle must not be delivered to an ultimate purchaser in a configuration that meets the definition of a tractor.

(c) The provisions of this paragraph (c) generally apply where the secondary vehicle manufacturer has substantial control over the design and assembly of emission controls. 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) Secondary manufacturers may finish assembly of partially complete vehicles in the following cases:

(i) You obtain a vehicle that is not fully assembled with the intent to manufacture a complete vehicle.

(ii) You obtain a vehicle with the intent to modify it before it reaches the ultimate purchaser. For example, this may apply for converting a gasoline-fueled vehicle to operate on natural gas.

(2) Manufacturers may introduce partially complete vehicles into U.S. commerce as described in this section if they have a written request for such vehicles from a secondary vehicle manufacturer that has certified the vehicle and will finish the vehicle assembly. The written request must include a statement that the secondary manufacturer has a certificate of conformity for the vehicle and identify a valid vehicle family name associated with each vehicle model ordered (or the basis for an exemption). 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 § 1037.620. 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) The manufacturer that will hold the certificate must include the following information in its 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 section 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 certificate holder, 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 (c)(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 (c)(2) of this section). We may set additional conditions under this paragraph (c)(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 vehicle family name that could be used to represent the vehicle model. Unless we approve otherwise in advance, you may do this only when shipping vehicles 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 vehicle family name when ordering vehicles from the original 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 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 you 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 (c)(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 your exemption for 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 your 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.

(d) 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 Exemption for vehicles intended for offroad use.

This section provides an exemption from the greenhouse gas standards of this part for certain vehicles intended to be used extensively in offroad environments such as forests, oil fields, and construction sites. This exemption does not exempt the engine from the standards of 40 CFR part 86 or part 1036.

(a) *Vocational vehicles.* Vocational vehicles meeting both of the following criteria are exempt without request, subject to the provisions of this section:

(1) The tires installed on the vehicle must be lug tires or contain a speed rating at or below 60 mph. For purposes of this section, a lug tire is one for which the elevated portion of the tread covers less than one-half of the tread surface.

(2) The vehicle must include a vehicle speed limiter governed to 55 mph or less.

(b) *Tractors.* Tractors meeting all the following criteria are exempt without request, subject to the provisions of this section:

(1) The tires installed on the vehicle must be lug tires or contain a speed rating at or below 60 mph. For purposes of this section, a lug tire is one for which the elevated portion of the tread covers less than one-half of the tread surface.

(2) The vehicle must include a vehicle speed limiter governed to 55 mph or less.

(3) The vehicle must either—

(i) Contain PTO controls; or

(ii) Have GVWR greater than 57,000 pounds and have axle configurations other than 4×2, 6×2, or 6×4 (axle configurations are expressed as total number of wheel hubs by number of drive wheel hubs).

(4) The frame of the vehicle must have a resisting bending moment (RBM) greater than 2,000,000 inch-pounds. Use good engineering judgment to determine the RBM for the frame.

(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) *Preapproval.* You may ask for preliminary approval that your vehicles qualify for this exemption. We may also require you to ask for preliminary approval for this exemption if we determine that you have not acted in good faith when applying this exemption in earlier model years.

(e) *Other vehicles.* In unusual circumstances, you may ask us to approve an exemption under this section for vehicles not fully meeting the criteria of either paragraph (a) or (b) of this section. We will approve your request only where we determine conclusively that the vehicles will be used primarily in offroad applications and cannot practically incorporate the greenhouse gas reducing design features.

Subpart H—Averaging, Banking, and Trading for Certification

§ 1037.701 General provisions.

(a) You may average, bank, and trade (ABT) emission credits for purposes of certification as described in this subpart to show compliance with the standards of §§ 1037.105 and 1037.106. Participation in this program is voluntary.

(b) Section 1037.740 restricts the use of emission credits to certain averaging sets.

(c) 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.

(d) You may not use emission credits generated under this subpart to offset any emissions that exceed an FEL or standard.

(e) [Reserved]

(f) Emission credits may be used in the model year they are generated. Surplus emission credits may be used for past model years or banked for future model years.

(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. Each vehicle's emission control information label must include the applicable FELs.

§ 1037.705 Generating and calculating emission credits.

The provisions of this section apply separately for calculating emission credits by pollutant.

(a) [Reserved]

(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 throughout the following equations:

(1) For vocational vehicles:

$$\text{Emission credits (Mg)} = (\text{Std} - \text{FEL}) \times (\text{Payload Tons}) \times (\text{Volume}) \times (\text{UL}) \times (10^{-6})$$

Where:

Std = the standard associated with the specific tractor regulatory subcategory (g/ton-mile).

FEL = the family emission limit for the vehicle subfamily (g/ton-mile).

Payload tons = the prescribed payload for each class in tons (2.85 tons for light heavy-duty vehicles, 5.6 tons for medium heavy-duty vehicles, and 19 tons for heavy heavy-duty vehicles).

Volume = (projected or actual) production volume of the vehicle subfamily.

UL = useful life of the vehicle (110,000 miles for light heavy-duty vehicles, 185,000 miles for medium heavy-duty vehicles, and 435,000 miles for heavy heavy-duty vehicles).

(2) For tractors:

$$\text{Emission credits (Mg)} = (\text{Std} - \text{FEL}) \times (\text{Payload tons}) \times (\text{Volume}) \times (\text{UL}) \times (10^{-6})$$

Where:

Std = the standard associated with the specific tractor regulatory subcategory (g/ton-mile).

FEL = the family emission limit for the vehicle subfamily (g/ton-mile).

Payload tons = the prescribed payload for each class in tons (12.5 tons for Class 7 and 19 tons for Class 8).

Volume = (projected or actual) production volume of the vehicle subfamily.

UL = useful life of the tractor (435,000 miles for Class 8 and 185,000 miles for Class 7).

(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 values for U.S.-directed production volumes. *See* § 1037.745 for provisions allowing you to continue production in cases where you have (or expect to have) a negative credit balance at the end of the year. Do not include any of the following vehicles to calculate emission credits:

(1) Vehicles that you do not certify because they are 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 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 is otherwise allowed by this part).

(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 applicable due date: 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, or from emission credits you obtain through trading.

§ 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.

(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.

§ 1037.720 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 may be used only within 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* § 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) 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 vehicle families to project your net credit balance 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 an end-of-year report within 90 days after the end of the model year and a final report within 270 days after the end of the model year. We may waive the requirement to send the end-of year report, conditioned upon you sending the final report on time. We will not waive this requirement where you have a deficit for that model year or an outstanding deficit for a prior model year.

(b) Your end-of-year and final reports must include the following information for each vehicle family participating in the ABT program:

(1) Vehicle-family and subfamily designations.

(2) The 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 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 end-of-year and final reports 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 (or is negative but allowed under § 1037.745).

(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 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 end-of-year report or final report as follows:

(1) You may correct any errors in your end-of-year report when you prepare the final report, as long as you send us the final report by the time it is due.

(2) If you or we determine within 270 days after the end of the model year 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 more than 270 days after the end of the model year. If you report a negative balance of emission credits, we may disallow corrections under this paragraph (f)(2).

(3) 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. 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 end-of-year 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. 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 §§ 1037.725 and 1037.730.

(d) Keep records of the vehicle identification number for each vehicle 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 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 What restrictions apply for using emission credits?

The following restrictions apply for using emission credits:

(a) *Averaging sets.* Emission credits may be exchanged only within an averaging set. There are eleven principal averaging sets for vehicles subject to this subpart.

(1) Vocational vehicles at or below 19,500 pounds GVWR.

(2) Vocational vehicles above 19,500 pounds GVWR but at or below 33,000 pounds GVWR.

(3) Vocational vehicles over 33,000 pounds GVWR.

(4) Low and mid roof day cab tractors at or above 26,000 pounds GVWR but below 33,000 pounds GVWR.

(5) High roof tractors at or above 26,000 pounds GVWR but below 33,000 pounds GVWR.

(6) Low roof day cab tractors at or above 33,000 pounds GVWR.

(7) Low roof sleeper cab tractors at or above 33,000 pounds GVWR.

(8) Mid roof day cab tractors at or above 33,000 pounds GVWR.

(9) Mid roof sleeper cab tractors at or above 33,000 pounds GVWR.

(10) High roof day cab tractors at or above 33,000 pounds GVWR.

(11) High roof sleeper cab tractors at or above 33,000 pounds GVWR.

(12) Note that other separate averaging sets also apply for emission credits not related to this subpart. For example, under § 1037.104, an additional averaging set comprises all vehicles subject to the standards of that section. Separate averaging sets also apply for engines under 40 CFR part 1036, including engines used in vehicles subject to this subpart.

(b) *Emission credits for later tiers of standards.* CO_2 credits generated relative to the standards of this part may not be used for later tiers of standards, except that credits generated before model year 2017 may be used for the tier of standards that begins in 2017.

(c) *Applying credits to prior year deficits.* Where your credit balance for the prior year is negative (*i.e.,* there was a credit deficit) you may apply only credits that are surplus after meeting your current year credit obligations.

(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, the certificate of any vehicle family certified to an FEL above the applicable standard for which you do not have sufficient credits for the model year when you submit your end-of-year report is void.

(a) Your certificate for a vehicle family for which you do not have sufficient CO_2 credits will be 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 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 apply only surplus credits to your deficit. You may not apply credits to a prior-year deficit 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.

(c) If you do not remedy the deficit with surplus credits within three model years, your certificate is void for that vehicle family. Note that voiding a certificate applies *ab initio* (that is, retroactively). 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.

§ 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 conditional 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. However, we may void the certificate of conformity 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 and the deficit is not allowed under § 1037.745.

(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.

(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.

(a) We may require you to submit a pre-certification compliance report to us for the upcoming model year or the year after the upcoming model year.

(b) 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 manufacturers' equivalent fuel consumption data that is required to be reported by NHTSA in 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 emissions or vehicle performance during emission testing or normal in-use operation. 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.

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.

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.

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.

B-pillar means the first vertical structure to the rear of the windshield or rear-most part of the driver's seat, whichever is further to the rear. Note: The first vertical structure to the rear of the windshield is generally the structure of the body into which the driver's door closes.

Cab-complete vehicle means a 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 a vehicle lacking some components of the cab is a cab-complete vehicle if it substantially includes the cab.

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.

Carbon-related exhaust emissions (CREE) has the meaning given in 40 CFR 600.002. Note that CREE represents the combined mass of carbon emitted as HC, CO, and CO_2, expressed as having a molecular weight equal to that of CO_2.

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 family for a given pollutant from either transient or steady-state testing.

Class means relating to GVWR classes, 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 means relating to a type of reciprocating, internal-combustion engine that is not a spark-ignition engine.

Curb weight has the meaning given in 40 CFR 86.1803, consistent with the provisions of § 1037.140.

Day cab means a type of tractor cab that is not a sleeper cab.

Designated Compliance Officer means the Manager, Heavy-Duty and Nonroad Engine Group (6405–J), U.S. Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460.

Designated Enforcement Officer means the Director, Air Enforcement Division (2242A), U.S. Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460.

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 emissions at the end of 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 emissions at the end of useful life to emissions at the low-hour test point.

(2) For additive deterioration factors, the difference between emissions at the end of useful life and emissions at the low-hour test point.

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 hybrid-electric 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-electric vehicles.

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 vehicle means a vehicle that is tested for certification. This includes a vehicle 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 to not 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.

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.

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 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.

Gross combined 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.

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 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.

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.

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.

Manufacture means the physical and engineering process of designing, constructing, and assembling a vehicle.

Manufacturer has the meaning given in section 216(1) of the Act. In general, this term includes any person who manufactures a vehicle or 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.

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. Use the date on which a vehicle is shipped from the factory in which you finish your assembly process as the date of manufacture for determining your model year. For example, where a certificate holder sells a cab-complete vehicle to a secondary vehicle manufacturer, the model year is based on the date the vehicle leaves the factory as a cab-complete vehicle.

Motor vehicle has the meaning given in 40 CFR 85.1703.

New motor vehicle 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. 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 hydrocarbons (NMHC) means the sum of all hydrocarbon species except methane, as measured according to 40 CFR part 1065.

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.

Placed into service means put into initial use for its intended purpose.

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.

Regulatory sub-category means one of following groups:

(1) Spark-ignition vehicles subject to the standards of § 1037.104. Note that this category includes most gasoline-fueled heavy-duty pickup trucks and vans.

(2) All other vehicles subject to the standards of § 1037.104. Note that this category includes most diesel-fueled heavy-duty pickup trucks and van.

(3) Vocational vehicles at or below 19,500 pounds GVWR.

(4) Vocational vehicles at or above 19,500 pounds GVWR but below 33,000 pounds GVWR.

(5) Vocational vehicles over 33,000 pounds GVWR.

(6) Low and mid roof day cab tractors at or above 26,000 pounds GVWR but below 33,000 pounds GVWR.

(7) High roof tractors at or above 26,000 pounds GVWR but below 33,000 pounds GVWR.

(8) Low roof day cab tractors at or above 33,000 pounds GVWR.

(9) Low roof sleeper cab tractors at or above 33,000 pounds GVWR.

(10) Mid roof day cab tractors at or above 33,000 pounds GVWR.

(11) Mid roof sleeper cab tractors at or above 33,000 pounds GVWR.

(12) High roof day cab tractors at or above 33,000 pounds GVWR.

(13) High roof sleeper cab tractors at or above 33,000 pounds GVWR.

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.

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. 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. For manufacturers owned by a parent company, the production limit applies to the production of the parent company and all its subsidiaries and the employee limit applies to the total number of employees of the parent company and all its subsidiaries.

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.

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 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.

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 means a vehicle capable of pulling trailers that is not intended to carry significant cargo other than cargo in the trailer, or any other vehicle intended for the primary purpose of pulling a trailer. For purposes of this definition, the term "cargo" includes permanently attached equipment such as fire-fighting equipment.

(1) The following vehicles are tractors:

(i) Any vehicle sold to an ultimate purchaser with a fifth wheel coupling installed.

(ii) Any vehicle sold to an ultimate purchaser with the rear portion of the frame exposed where the length of the exposed portion is 5.0 meters or less. *See* § 1037.620 for special provisions related to vehicles sold to secondary vehicle manufacturers in this condition.

(2) The following vehicles are not tractors:

(i) Any vehicle sold to an ultimate purchaser with an installed cargo-carrying feature. For example, this would include dump trucks and cement trucks.

(ii) Any vehicle lacking a fifth wheel coupling sold to an ultimate purchaser with the rear portion of the frame exposed where the length of the exposed portion is more than 5.0 meters.

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 the criteria of paragraph (1)(i) or (ii) 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.

(2) Vehicles 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 or a fully functional vehicle that is designed to pull a trailer.

(ii) An *incomplete vehicle* is a vehicle that is not a complete vehicle when it is first sold as a vehicle. This includes sales to secondary vehicle manufacturers. Incomplete vehicles may also be cab-complete vehicles.

(3) Equipment such as trailers that are not self-propelled are not "vehicles" under this part 1037, but may be considered part of a "motor vehicle".

Vehicle configuration means a unique combination of vehicle hardware and calibration within a vehicle family. Vehicles within a vehicle configuration differ only with respect to normal production variability or factors unrelated to emissions.

Vehicle family has the meaning given in § 1037.230.

Vehicle subfamily or *subfamily* means a subset of a vehicle family including vehicles subject to the same FEL(s).

Vocational means relating to a vehicle subject to the standards of § 1037.105.

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, acronyms, and abbreviations.

The following symbols, acronyms, and abbreviations apply to this part:

AECD auxiliary emission control device
CFR Code of Federal Regulations
CH_4 methane
CO carbon monoxide
CO_2 carbon dioxide
CREE carbon-related exhaust emissions
DF deterioration factor
DOT Department of Transportation
EPA Environmental Protection Agency
FEL Family Emission Limit
G grams
HC hydrocarbon
ISO International Organization for Standardization
Kg kilograms
M meter
mph miles per hour
N_2O nitrous oxide
NARA National Archives and Records Administration
NHTSA National Highway Transportation Safety Administration
NIST National Institute of Standards and Technology
NMHC nonmethane hydrocarbons
NMHCE nonmethane hydrocarbon equivalent
NO_X oxides of nitrogen (NO and NO_2)
NTE not-to-exceed
PM particulate matter
RBM resisting bending moment
RGWP relative global-warming potential
Rpm revolutions per minute
SAE Society of Automotive Engineers
SEA Selective enforcement audit
THC total hydrocarbon
THCE total hydrocarbon equivalent
TRU transportation refrigeration unit
U.S.C. United States Code
VIN vehicle identification number
WF work factor

§ 1037.810 Incorporation by reference.

(a) The documents referenced in this section have been incorporated by reference in this part. The incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies may be inspected at the U.S. Environmental Protection Agency, Office of Air and Radiation, 1200 Pennsylvania Ave., NW., Washington, DC 20460, phone (202) 272–0167, or 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* and is available from the sources listed below:

(b) *ISO Material.* This paragraph (b) lists material from the International Organization for Standardization that we have incorporated by reference. Anyone may purchase copies of these materials from the International Organization for Standardization, Case Postale 56, CH–1211 Geneva 20, Switzerland or *http://www.iso.org.*

(1) ISO/DIS–28580:2009 "INSERT TRR TITLE"; IBR approved for § 1037.520.

(2) [Reserved]

(c) *GEM Model.* EPA has published the GEM computer model. 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 www.epa.gov. This IBR is approved for § 1037.520.

§ 1037.815 What provisions apply to 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, 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* § 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. For example, equipment manufacturers must submit reports and keep records related to the flexibility provisions in § 1037.625.

(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 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 data that may be appropriate for collecting during testing of in-use vehicles using portable analyzers.

Appendix I to Part 1037—Heavy-Duty Transient Chassis Test Cycle

BILLING CODE 6560–50–P

Time	Speed	Speed
sec.	mph	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

Time	Speed	Speed
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

Time	Speed	Speed
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
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

Time	Speed	Speed
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

Time	Speed	Speed
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

Time	Speed	Speed
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

Time	Speed	Speed
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

Time	Speed	Speed
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
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

Time	Speed	Speed
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

Time	Speed	Speed
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

Time	Speed	Speed
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

Time	Speed	Speed
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

Time	Speed	Speed
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
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

Time	Speed	Speed
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

Time	Speed	Speed
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

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Appendix II to Part 1037—Power Take-Off Test Cycle

Cycle Simulation	Mode	Time	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

PART 1065—ENGINE-TESTING PROCEDURES

11. The authority citation for part 1065 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart A—[Amended]

12. Section 1065.1 is amended by adding paragraph (h) to read as follows:

§ 1065.1 Applicability.

* * * * *

(h) 40 CFR part 1066 describes how to measure emissions vehicles that are subject to standards in g/mile or g/kilometer. Those vehicle testing provisions extensively reference portions of this part 1065. See 40 CFR part 1066 and the standard-setting part for additional information.

Subpart K—[Amended]

13. 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	g/mol ($10^{-3}\cdot kg\cdot mol^{-1}$)
M_{air}	molar mass of dry air 1	28.96559
M_{Ar}	molar mass of argon	39.948
M_{C}	molar mass of carbon	16.0425
M_{C3H8}	molar mass of propane	44.09562
M_{CH4}	molar mass of methane	16.043
M_{CO}	molar mass of carbon monoxide	28.0101
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_{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_{NMHC}	effective molar mass of nonmethane hydrocarbon[2]	13.875389
M_{NMHCE}	effective molar mass of nonmethane equivalent hydrocarbon[2]	13.875389
M_{NOx}	effective molar mass of oxides of nitrogen[3]	46.0055
M_{N2O}	effective 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 molar mass of total hydrocarbon[2]	13.875389
M_{THCE}	effective 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 by an atomic hydrogen-to-carbon ratio, α, of 1.85.

[3]The effective molar mass of NOx is defined by the molar mass of nitrogen dioxide, NO_2.

* * * * *

14. A new part 1066 is added to subchapter U to read as follows:

PART 1066—VEHICLE-TESTING PROCEDURES

Authority: 42 U.S.C. 7401–7671q.

Subpart A—Applicability and General Provisions

§ 1066.1 Applicability.

(a) This part describes the procedures that apply to testing we require for the following vehicles:

(1) Model year 2014 and later heavy-duty highway vehicles we regulate under 40 CFR part 1037.

(2) [Reserved]

(b) The procedures of this part may apply to other types of vehicles, as described in this part and in the standard-setting part.

(c) The term "you" means anyone performing testing under this part other than EPA.

(1) This part is addressed primarily to manufacturers of vehicles, but it applies equally to anyone who does testing under this part for such manufacturers.

(2) This part applies to any manufacturer or supplier of test equipment, instruments, supplies, or any other goods or services related to the procedures, requirements, recommendations, or options in this part.

(d) Paragraph (a) of this section identifies the parts of the CFR that define emission standards and other requirements for particular types of vehicles. In this part, we refer to each of these other parts generically as the "standard-setting part." For example, 40 CFR part 1037 is the standard-setting part for heavy-duty highway vehicles.

(e) Unless we specify otherwise, the terms "procedures" and "test procedures" in this part include all aspects of vehicle testing, including the equipment specifications, calibrations, calculations, and other protocols and procedural specifications needed to measure emissions.

(f) For additional information regarding these test procedures, visit our Web site at *http://www.epa.gov,* and in particular *http://www.epa.gov/nvfel/testing/regulations.htm.*

§ 1066.2 Submitting information to EPA under this part.

(a) You are responsible for statements and information in your applications for certification, requests for approved procedures, selective enforcement audits, laboratory audits, production-line test reports, field test reports, or any other statements you make to us related to this part 1066. If you provide statements or information to someone for submission to EPA, you are responsible for these statements and information as if you had submitted them to EPA yourself.

(b) In the standard-setting part and in 40 CFR 1068.101, we describe your obligation to report truthful and complete information and the consequences of failing to meet this obligation. *See also* 18 U.S.C. 1001 and 42 U.S.C. 7413(c)(2). This obligation applies whether you submit this information directly to EPA or through someone else.

(c) We may void any certificates or approvals associated with a submission of information if we find that you intentionally submitted false, incomplete, or misleading information. For example, if we find that you intentionally submitted incomplete information to mislead EPA when requesting approval to use alternate test procedures, we may void the certificates for all engine families certified based on emission data collected using the alternate procedures. This would also apply if you ignore data from incomplete tests or from repeat tests with higher emission results.

(d) We may require an authorized representative of your company to approve and sign the submission, and to certify that all of the information submitted is accurate and complete. This includes everyone who submits information, including manufacturers and others.

(e) *See* 40 CFR 1068.10 for provisions related to confidential information. Note however that under 40 CFR 2.301, emission data is generally not eligible for confidential treatment.

(f) Nothing in this part should be interpreted to limit our ability under Clean Air Act section 208 (42 U.S.C. 7542) to verify that vehicles conform to the regulations.

§ 1066.5 Overview of this part 1066 and its relationship to the standard-setting part.

(a) This part specifies procedures that can apply generally to testing various categories of vehicles. *See* the standard-setting part for directions in applying specific provisions in this part for a particular type of vehicle. Before using this part's procedures, read the standard-setting part to answer at least the following questions:

(1) What drive schedules must I use for testing?

(2) Should I warm up the test vehicle before measuring emissions, or do I need to measure cold-start emissions during a warm-up segment of the duty cycle?

(3) Which exhaust constituents do I need to measure? Measure all exhaust constituents that are subject to emission standards, any other exhaust constituents needed for calculating emission rates, and any additional exhaust constituents as specified in the standard-setting part. We may approve your request to omit measurement of N_2O and CH_4 for a vehicle, provided it is not subject to an N_2O or CH_4 emission standard and we determine that other information is available to give us a reasonable basis for estimating or approximating the vehicle's emission rates.

(4) Do any unique specifications apply for test fuels?

(5) What maintenance steps may I take before or between tests on an emission-data vehicle?

(6) Do any unique requirements apply to stabilizing emission levels on a new vehicle?

(7) Do any unique requirements apply to test limits, such as ambient temperatures or pressures?

(8) Is field testing required or allowed, and are there different emission standards or procedures that apply to field testing?

(9) Are there any emission standards specified at particular operating conditions or ambient conditions?

(10) Do any unique requirements apply for durability testing?

(b) The testing specifications in the standard-setting part may differ from the specifications in this part. In cases where it is not possible to comply with both the standard-setting part and this part, you must comply with the specifications in the standard-setting part. The standard-setting part may also allow you to deviate from the procedures of this part for other reasons.

(c) The following table shows how this part divides testing specifications into subparts:

Table 1 of § 1066.5—Description of Part 1066 subparts.

This subpart	Describes these specifications or procedures
Subpart A	Applicability and general provisions.
Subpart B	Equipment for testing.
Subpart C	Coastdowns for testing.
Subpart D	How to prepare your vehicle and run an emissions test over a predetermined duty cycle.
Subpart E	How to test with hybrid vehicles.
Subpart F	Reserved.
Subpart G	Test procedure calculations.
Subpart H	Definitions and reference material.

§ 1066.10 Other procedures.

(a) *Your testing.* The procedures in this part apply for all testing you do to show compliance with emission standards, with certain exceptions listed in this section. In some other sections in this part, we allow you to use other procedures (such as less precise or less accurate procedures) if they do not affect your ability to show that your vehicles comply with the applicable emission standards. This generally requires emission levels to be far enough below the applicable emission standards so that any errors caused by greater imprecision or inaccuracy do not affect your ability to state unconditionally that the engines meet all applicable emission standards.

(b) *Our testing.* These procedures generally apply for testing that we do to determine if your vehicles comply with applicable emission standards. We may perform other testing as allowed by the Act.

(c) *Exceptions.* We may allow or require you to use procedures other than those specified in this part in the following cases, which may apply to laboratory testing, field testing, or both. We intend to publicly announce when we allow or require such exceptions. The provisions of 40 CFR 1065.10(c) apply for testing under this part. All of the test procedures noted there as exceptions to the specified procedures are considered generically as "other procedures." Note that the terms "special procedures" and "alternate procedures" have specific meanings; "special procedures" are those allowed by 40 CFR 1065.10(c)(2) and "alternate procedures" are those allowed by 40 CFR 1065.10(c)(7). If we require you to request approval to use other procedures under this paragraph (c), you may not use them until we approve your request.

§ 1066.15 Overview of test procedures.

This section outlines the procedures to test vehicles that are subject to emission standards.

(a) In the standard-setting part, we set emission standards in g/mile (or g/km), for the following constituents:

(1) Total oxides of nitrogen, NO_X.

(2) Hydrocarbons (HC), which may be expressed in the following ways:

(i) Total hydrocarbons, THC.

(ii) Nonmethane hydrocarbons, NMHC, which results from subtracting methane (CH_4) from THC.

(iii) Total hydrocarbon-equivalent, THCE, which results from adjusting THC mathematically to be equivalent on a carbon-mass basis.

(iv) Nonmethane hydrocarbon-equivalent, NMHCE, which results from adjusting NMHC mathematically to be equivalent on a carbon-mass basis.

(3) Particulate mass, PM.

(4) Carbon monoxide, CO.

(b) Note that some vehicles may not be subject to standards for all the emission constituents identified in paragraph (a) of this section.

(c) We generally set emission standards over test intervals and/or drive schedules, as follows:

(1) *Vehicle operation.* Testing may involve measuring emissions and miles travelled in a laboratory-type environment or in the field. The standard-setting part specifies how test intervals are defined for field testing. Refer to the definitions of "duty cycle" and "test interval" in § 1066.701. Note that a single drive schedule may have multiple test intervals and require weighting of results from multiple test phases to calculate a composite distance-based emission value to compare to the standard.

(2) *Constituent determination.* Determine the total mass of each constituent over a test interval by selecting from the following methods:

(i) *Continuous sampling.* In continuous sampling, measure the constituent's concentration continuously from raw or dilute exhaust. Multiply this concentration by the continuous (raw or dilute) flow rate at the emission sampling location to determine the constituent's flow rate. Sum the constituent's flow rate continuously over the test interval. This sum is the total mass of the emitted constituent.

(ii) *Batch sampling.* In batch sampling, continuously extract and store a sample of raw or dilute exhaust for later measurement. Extract a sample proportional to the raw or dilute exhaust flow rate, as applicable. You may extract and store a proportional sample of exhaust in an appropriate container, such as a bag, and then measure HC, CO, and NO_X concentrations in the container after the test phase. You may deposit PM from proportionally extracted exhaust onto an appropriate substrate, such as a filter. In this case, divide the PM by the amount of filtered exhaust to calculate the PM concentration. Multiply batch sampled concentrations by the total (raw or dilute) flow from which it was extracted during the test interval. This product is the total mass of the emitted constituent.

(iii) *Combined sampling.* You may use continuous and batch sampling simultaneously during a test interval, as follows:

(A) You may use continuous sampling for some constituents and batch sampling for others.

(B) You may use continuous and batch sampling for a single constituent, with one being a redundant measurement, subject to the provisions of 40 CFR 1065.201.

(d) Refer to the standard-setting part for calculations to determine g/mile emission rates.

(e) The regulation highlights several specific cases where good engineering judgment is especially relevant. You must use good engineering judgment for all aspects of testing under this part, not only for those provisions where we specifically re-state this requirement.

§ 1066.20 Units of measure and overview of calculations.

(a) *System of units.* The procedures in this part follows both conventional English Units and the International System of Units (SI), as detailed in NIST Special Publication 811, 1995 Edition, "Guide for the Use of the International System of Units (SI)," which we incorporate by reference in § 1066.710. This document is available on the Internet at *http://www.nist.gov/physlab/pubs/sp811.*

(b) *Units conversion.* Use good engineering judgment to convert units between measurement systems as needed. The following conventions are used throughout this document and should be used to convert units as applicable:

(1) 1 hp = 33,000 ft·lbf/min = 550 ft·lbf/s = 0.7457 kW.

(2) 1 lbf = 32.174 ft·lbm/s2 = 4.4482 N.

(3) 1 inch = 25.4 mm.

(c) *Rounding.* Unless the standard-setting part specifies otherwise, round only final values, not intermediate values. Round values to the number of significant digits necessary to match the number of decimal places of the applicable standard or specification. For information not related to standards or specifications, use good engineering judgment to record the appropriate number of significant digits.

(d) *Interpretation of ranges.* Interpret a range as a tolerance unless we explicitly identify it as an accuracy, repeatability, linearity, or noise specification. *See* 40 CFR 1065.1001 for the definition of tolerance. In this part, we specify two types of ranges:

(1) Whenever we specify a range by a single value and corresponding limit values above and below that value, target any associated control point to that single value. Examples of this type of range include "±10% of maximum pressure", or "(30 ±10) kPa".

(2) Whenever we specify a range by the interval between two values, you may target any associated control point to any value within that range. An example of this type of range is "(40 to 50) kPa".

(e) *Scaling of specifications with respect to an applicable standard.* Because this part 1066 is applicable to a wide range of vehicles and emission standards, some of the specifications in this part are scaled with respect to a vehicle's applicable standard or weight. This ensures that the specification will be adequate to determine compliance, but not overly burdensome by requiring unnecessarily high-precision equipment. Many of these specifications are given with respect to a "flow-weighted mean" that is expected at the standard or during testing. Flow-weighted mean is the mean of a quantity after it is weighted proportional to a corresponding flow rate. For example, if a gas concentration is measured continuously from the raw exhaust of an engine, its flow-weighted mean concentration is the sum of the products of each recorded concentration times its respective exhaust flow rate, divided by the sum of the recorded flow rates. As another example, the bag concentration from a CVS system is the same as the flow-weighted mean concentration, because the CVS system itself flow-weights the bag concentration. Refer to 40 CFR 1065.602 for information needed to estimate and calculate flow-weighted means.

§ 1066.25 Recordkeeping.

The procedures in this part include various requirements to record data or other information. Refer to the standard-setting part regarding recordkeeping requirements. If the standard-setting part does not specify recordkeeping requirements, store these records in any format and on any media and keep them readily available for one year after you send an associated application for certification, or one year after you generate the data if they do not support an application for certification. You must promptly send us organized, written records in English if we ask for them. We may review them at any time.

Subpart B—Equipment, Fuel, and Gas Specifications

§ 1066.101 Overview.

(a) This subpart addresses equipment related to emission testing, as well as test fuels and analytical gases. This section addresses emission sampling and analytical equipment, test fuels, and analytical gases. The remainder of this subpart addresses chassis dynamometers and related equipment.

(b) The provisions of 40 CFR part 1065 specify engine-based procedures for measuring emissions. Except as specified otherwise in this part, the provisions of 40 CFR part 1065 apply for testing required by this part as follows:

(1) The provisions of 40 CFR 1065.140 through 1065.195 specify equipment for exhaust dilution and sampling systems.

(2) The provisions of 40 CFR part 1065, subparts C and D, specify measurement instruments and their calibrations.

(3) The provisions of 40 CFR part 1065, subpart H, specify fuels, engine fluids, and analytical gases.

(4) The provisions of 40 CFR part 1065, subpart J, describe how to measure emissions from vehicles operating outside of a laboratory, except that provisions related to measuring engine work do not apply.

(c) The provisions of this subpart are intended to specify systems that can very accurately and precisely measure emissions from motor vehicles. We may waive or modify the specifications and requirements of this part for testing highway motorcycles or nonroad vehicles, consistent with good engineering judgment. For example, it may be appropriate to allow the use of a hydrokinetic dynamometer that is not able to meet all the performance specifications described in this subpart.

§ 1066.110 Dynamometers.

(a) *General requirements.* A chassis dynamometer typically uses electrically generated load forces combined with the rotational inertia of the dynamometer to recreate the mechanical inertia and frictional forces that a vehicle exerts on road surfaces (known as "road load"). Load forces are calculated using vehicle-specific coefficients and response characteristics. The load forces are applied to the vehicle tires by rolls connected to intermediate motor/absorbers. The dynamometer uses a load cell to measure the forces the dynamometer rolls apply to the vehicle's tires.

(b) *Accuracy and precision.* The dynamometer's output values for road load must be NIST-traceable. We may determine traceability to a specific international standards organization to be sufficient to demonstrate NIST-traceability. The force-measurement system must be capable of indicating force readings to a resolution of 0.1% of the maximum forces simulated by the dynamometer during a test.

(c) *Test cycles.* The dynamometer must be capable of fully simulating applicable test cycles for the vehicles being tested as referenced in the corresponding standard-setting part.

(1) For light-duty vehicles and for heavy-duty vehicles with a gross vehicle weight rating (GVWR) at or below 14,000 lbs, the dynamometer must be able to fully simulate a driving schedule with a maximum speed of 80.3 mph and a maximum acceleration rate of 8.0 mph/s in two-wheel drive and four-wheel drive configurations.

(2) For heavy-duty vehicles with GVWR above 14,000 lbs, the dynamometer must be able to fully simulate a driving schedule with a

maximum speed of 65.0 mph and a maximum acceleration rate of 3.0 mph/s in either two-wheel drive or four-wheel drive configurations.

(d) *Component requirements.* The dynamometer must have an independent drive roll for each axle being driven by the vehicle.

(1) For light-duty vehicles and for heavy-duty vehicles with GVWR at or below 14,000 lbs, the nominal roll diameter must be 1.20 to 1.25 meters (this is commonly referred to as a 48-inch roll dynamometer).

(2) For heavy-duty vehicles with GVWR above 14,000 lbs, the nominal roll diameter must be at least 1.20 meters and no great than 1.85 meters. Use good engineering judgment to ensure that the dynamometer roll diameter is large enough to provide sufficient tire-roll contact area for avoiding tire overheating and power losses from tire-roll slippage.

(3) If you measure force and speed at 10 Hz or faster, you may use good engineering judgment to convert those measurements to 1-Hz, 2-Hz, or 5-Hz values.

(4) The load applied by the dynamometer simulates forces acting on the vehicle during normal driving according to the following equation:

$$FR_{\mathrm{i}} = A + B \cdot S_{\mathrm{i}} + C \cdot S_{\mathrm{i}}^{2} + M \cdot \frac{S_{\mathrm{i}} - S_{\mathrm{i-1}}}{t_{\mathrm{i}} - t_{\mathrm{i-1}}}$$

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* is 6,000.

A = constant value representing the vehicle's frictional load in lbf or newtons. *See* subpart C of this part.

B = coefficient representing load from drag and rolling resistance, which are a function of vehicle speed, in lbf/mph or newtons/kph. *See* subpart C of this part.

S = linear speed at the roll surfaces as measured by the dynamometer, in mph or kph. Let $S_{i-1} = 0$.

C = coefficient representing aerodynamic effects, which are a function of vehicle speed squared, in lbf/mph² or newton/kph². *See* subpart C of this part.

M = mass of vehicle in lbm or kg. Determine the vehicle's mass based on the test weight, taking into account the effect of rotating axles, as specified in § 1066.304 dividing the weight by the acceleration due to gravity as specified in 40 CFR 1065.630.

t = elapsed time in the driving schedule as measured by the dynamometer, in seconds. Let $t_{i-1} = 0$.

(5) Measured values of road load force may not differ from the corresponding calculated values at any operating conditions by more than ± 1% or ± 2.2 lbf, whichever is greater.

(e) *Dynamometer manufacturer instructions.* This part specifies that you follow the dynamometer manufacturer's recommended procedures for things such as calibrations and general operation. If you perform testing with a dynamometer that you manufactured or if you otherwise do not have these recommended procedures, use good engineering judgment to establish the additional procedures and specifications we specify in this part, unless we specify otherwise. Keep records to describe these recommended procedures and how they are consistent with good engineering judgment.

§ 1066.115 Summary of verification and calibration procedures for chassis dynamometers.

(a) *Overview.* This section describes the overall process for verifying and calibrating the performance of chassis dynamometers.

(b) *Scope and frequency.* The following table summarizes the required and recommended calibrations and verifications described in this subpart and indicates when these have to be performed:

Table 1 of § 1066.115–Summary of required dynamometer calibrations and verifications.

Type of calibration or verification	Minimum frequency[a]
§ 1066.120: Linearity verification	Speed: Upon initial installation, within 370 days before testing, and after major maintenance. Torque (load): Upon initial installation, within 370 days before testing, and after major maintenance.
§ 1066.125: Roll runout and diameter	Upon initial installation and after major maintenance.
§ 1066.130: Time	Upon initial installation and after major maintenance.
§ 1066.135: Speed measurement	Upon initial installation, within 35 days before testing, and after major maintenance.
§ 1066.140: Torque (load) transducer	Upon initial installation, within 370 days before testing, and after major maintenance.
§ 1066.145: Response time	Upon initial installation and after major maintenance.
§ 1066.150: Base inertia	Upon initial installation and after major maintenance.
§ 1066.155: Parasitic loss	Upon initial installation, within 7 days before testing, and after major maintenance.
§ 1066.160: Parasitic friction compensation evaluation	Upon initial installation, within 7 days before testing, and after major maintenance.
§ 1066.165: Acceleration and deceleration	Upon initial installation and after major maintenance.
§ 1066.170: Unloaded coastdown	Upon initial installation, within 7 days before testing, and after major maintenance.

[a]Perform calibrations and verifications more frequently, according to measurement system manufacturer instructions and good engineering judgment.

(c) *Automated dynamometer verifications and calibrations.* In some cases, dynamometers are designed with internal diagnostic and control features to accomplish the verifications and calibrations specified in this subpart. You may use these automated functions instead of following the procedures we specify in this subpart to demonstrate compliance with applicable requirements, consistent with good engineering judgment.

(d) *Sequence of verifications and calibrations.* Upon initial installation and after major maintenance, perform the verifications and calibrations in the same sequence as noted in Table 1 of this section. At other times, you may need to perform specific verifications or calibration in a certain sequence, as noted in this subpart.

(e) *Corrections.* Unless the regulations direct otherwise, if the dynamometer fails to meet any specified calibration or verification, make any necessary adjustments or repairs such that the dynamometer meets the specification before running a test. Repairs required to meet specifications are generally considered major maintenance under this part.

§ 1066.120 Linearity verification.

(a) *Scope and frequency.* Perform linearity verifications as specified in Table 1 of this section at least as frequently as indicated in the table, consistent with the dynamometer manufacturer's recommendations and good engineering judgment. Note that these linearity verifications may replace requirements we previously referred to as calibrations. The intent of linearity verification is to determine that a measurement system responds accurately and proportionally over the measurement range of interest. Linearity verification generally consists of introducing a series of at least 10 reference values (or the manufacturer's recommend number of reference values) to a measurement system. The measurement system quantifies each reference value. The measured values are then collectively compared to the reference values by using a least-squares linear regression and the linearity criteria specified in Table 1 of this section.

(b) *Performance requirements.* If a measurement system does not meet the applicable linearity criteria in Table 1 of this section, correct the deficiency by re-calibrating, servicing, or replacing components as needed. Repeat the linearity verification after correcting the deficiency to ensure that the measurement system meets the linearity criteria. Before you may use a measurement system that does not meet linearity criteria, you must demonstrate to us that the deficiency does not adversely affect your ability to demonstrate compliance with the applicable standards.

(c) *Procedure.* Use the following linearity verification protocol, or use good engineering judgment to develop a different protocol that satisfies the intent of this section, as described in paragraph (a) of this section:

(1) In this paragraph (c), the letter "y" denotes a generic measured quantity, the superscript over-bar denotes an arithmetic mean (such as $\bar{y}$), and the subscript "$_{ref}$" denotes the known or reference quantity being measured.

(2) Operate a dynamometer system at the specified temperatures and pressures. This may include any specified adjustment or periodic calibration of the dynamometer system.

(3) Set dynamometer speed and torque to zero and apply the dynamometer brake to ensure a zero-speed condition.

(4) Span the dynamometer speed or torque signal.

(5) After spanning, check for zero speed and torque. Use good engineering judgment to determine whether or not to rezero or re-span before continuing.

(6) For both speed and torque, use the dynamometer manufacturer's recommendations and good engineering judgment to select reference values, y_{refi}, that cover a range of values that you expect would prevent extrapolation

beyond these values during emission testing. We recommend selecting zero speed and zero torque as reference values for the linearity verification.

(7) Use the dynamometer manufacturer's recommendations and good engineering judgment to select the order in which you will introduce the series of reference values. For example, you may select the reference values randomly to avoid correlation with previous measurements or the influence of hysteresis; you may select reference values in ascending or descending order to avoid long settling times of reference signals; or you may select values to ascend and then descend to incorporate the effects of any instrument hysteresis into the linearity verification.

(8) Set the dynamometer to operate at a reference condition.

(9) Allow time for the dynamometer to stabilize while it measures the reference values.

(10) At a recording frequency of at least 1 Hz, measure speed and torque values for 30 seconds and record the arithmetic mean of the recorded values, $\bar{y}_i$. Refer to 40 CFR 1065.602 for an example of calculating an arithmetic mean.

(11) Repeat the steps in paragraphs (c)(8) though (10) of this section until you measure speeds and torques at each of the reference conditions.

(12) Use the arithmetic means, $\bar{y}_i$, and reference values, y_{refi}, to calculate least-squares linear regression parameters and statistical values to compare to the minimum performance criteria specified in Table 1 of this section. Use the calculations described in 40 CFR 1065.602. Using good engineering judgment, you may weight the results of individual data pairs (*i.e.*, (y_{refi},$\bar{y}_i$)), in the linear regression calculations.

Table 1 of § 1066.120–
Dynamometer measurement systems that require linearity verifications

Measurement system	Quantity	Linearity criteria			
		$\lvert x_{min}(a_1-1)+a_0 \rvert$	a_1	SEE	r^2
Speed	S	$\leq 0.05\ \% \cdot S_{max}$	0.98-1.02	$\leq 2\ \% \cdot S_{max}$	≥ 0.990
Torque (load)	T	$\leq 1\ \% \cdot T_{max}$	0.98-1.02	$\leq 2\ \% \cdot T_{max}$	≥ 0.990

§ 1066.125 Roll runout and diameter verification procedure.

(a) *Overview.* This section describes the verification procedure for roll runout and roll diameter. Roll runout is a measure of the variation in roll radius around the circumference of the roll.

(b) *Scope and frequency.* Perform these verifications upon initial installation and after major maintenance.

(c) *Roll runout procedure.* Verify roll runout as follows:

(1) Perform this verification with laboratory and dynamometer temperatures stable and at equilibrium. Release the roll brake and shut off power to the dynamometer. Remove any dirt, rubber, rust, and debris from the roll surface. Mark measurement locations on the roll surface using a permanent marker. Mark the roll at a minimum of four equally spaced locations across the roll width; we recommend taking measurements every 150 mm across the roll. Secure the marker to the deck plate adjacent to the roll surface and slowly rotate the roll to mark a clear line around the roll circumference. Repeat this process for all measurement locations.

(2) Measure roll runout using a dial indicator with a probe that allows for measuring the position of the roll surface relative to the roll centerline as it turns through a complete revolution. The dial indicator must have a magnetic base assembly or other means of being securely mounted adjacent to the roll. The dial indicator must have sufficient range to measure roll runout at all points, with a minimum accuracy and precision of ± 0.025 mm. Calibrate the dial indicator according to the instrument manufacturer's instructions.

(3) Position the dial indicator adjacent to the roll surface at the desired measurement location. Position the shaft of the dial indicator perpendicular to the roll such that the point of the dial indicator is slightly touching the surface of the roll and can move freely through a full rotation of the roll. Zero the dial indicator according to the instrument manufacturer's instructions. Avoid distortion of the runout measurement from the weight of a person standing on or near the mounted dial indicator.

(4) Slowly turn the roll through a complete rotation and record the maximum and minimum values from the dial indicator. Calculate runout from the difference between these maximum and minimum values.

(5) Repeat the steps in paragraphs (c)(3) and (4) of this section for all measurement locations.

(6) The roll runout must be less than 0.25 mm at all measurement locations.

(d) *Diameter procedure.* Verify roll diameter based on the following procedure, or an equivalent procedure based on good engineering judgment:

(1) Prepare the laboratory and the dynamometer as specified in paragraph (c)(1) of this section.

(2) Measure roll diameter using a Pi Tape®. Orient the Pi Tape® to the marker line at the desired measurement location with the Pi Tape® hook pointed outward. Temporarily secure the Pi Tape® to the roll near the hook end with adhesive tape. Slowly turn the roll, wrapping the Pi Tape® around the roll surface. Ensure that the Pi Tape® is flat and adjacent to the marker line around the full circumference of the roll. Attach a 2-kg weight to the hook of the Pi Tape® and position the roll so that the weight dangles freely. Remove the adhesive tape without disturbing the orientation or alignment of the Pi Tape®.

(3) Overlap the gage member and the vernier scale ends of the Pi Tape® to read the diameter measurement to the nearest 0.01 mm. Follow the manufacturer's recommendation to correct the measurement to 25 °C, if applicable.

(4) Repeat the steps in paragraphs (d)(2) and (3) of this section for all measurement locations.

(5) The measured roll diameter must be within ± 0.25 mm of the specified nominal value at all measurement locations. You may revise the nominal value to meet this specification, as long as you use the corrected nominal value for all calculations in this subpart.

§ 1066.130 Time verification procedure.

(a) *Overview.* This section describes how to verify the accuracy of the dynamometer's timing device.

(b) *Scope and frequency.* Perform this verification upon initial installation and after major maintenance.

(c) *Procedure.* Perform this verification using one of the following procedures:

(1) *WWV method.* You may use the time and frequency signal broadcast by NIST from radio station WWV as the time standard if the trigger for the dynamometer timing circuit has a frequency decoder circuit, as follows:

(i) Dial station WWV at (303) 499–7111 and listen for the time announcement. Verify that the trigger started the dynamometer timer. Use good engineering judgment to minimize error in receiving the time and frequency signal.

(ii) After at least 1,000 seconds, re-dial station WWV and listen for the time announcement. Verify that the trigger stopped the dynamometer timer.

(iii) Compare the measured elapsed time, y_{act}, to the corresponding time standard, y_{ref}, to determine the time error, y_{error}, using the following equation:

$$y_{error} = \frac{y_{act} - y_{ref}}{y_{ref}} \cdot 100\ \% \qquad \text{Eq. 1066.130-1}$$

(2) *Ramping method.* You may set up an operator-defined ramp function in the signal generator to serve as the time standard as follows:

(i) Set up the signal generator to output a marker voltage at the peak of each ramp to trigger the dynamometer timing circuit. Output the designated marker voltage to start the verification period.

(ii) After at least 1,000 seconds, output the designated marker voltage to end the verification period.

(iii) Compare the measured elapsed time between marker signals, y_{act}, to the corresponding time standard, y_{ref}, to determine the time error, y_{error}, using Equation 1066.130–1.

(3) *Dynamometer coastdown method.* You may use a signal generator to output a known speed ramp signal to the dynamometer controller to serve as the time standard as follows:

(i) Generate upper and lower speed values to trigger the start and stop functions of the coastdown timer circuit. Use the signal generator to start the verification period.

(ii) After at least 1,000 seconds, use the signal generator to end the verification period.

(iii) Compare the measured elapsed time between trigger signals, y_{act}, to the corresponding time standard, y_{ref}, to determine the time error, y_{error}, using Equation 1066.130–1.

(d) *Performance evaluation.* The time error determined in paragraph (c) of this section may not exceed ±0.001%.

§ 1066.135 Speed verification procedure.

(a) *Overview.* This section describes how to verify the accuracy and resolution of the dynamometer speed determination.

(b) *Scope and frequency.* Perform this verification upon initial installation, within 35 days before testing, and after major maintenance.

(c) *Procedure.* Use one of the following procedures to verify the accuracy and resolution of the dynamometer speed simulation:

(1) *Pulse method.* Connect a universal frequency counter to the output of the dynamometer's speed-sensing device in parallel with the signal to the dynamometer controller. The universal frequency counter must be calibrated according to the instrument manufacturer's instructions and be capable of measuring with enough accuracy to perform the procedure as specified in this paragraph (c)(1). Make sure the instrumentation does not affect the signal to the dynamometer control circuits. Determine the speed error as follows:

(i) Set the dynamometer to speed control mode. Set the dynamometer speed to a value between 15 kph and the maximum speed expected during testing; record the output of the frequency counter after 10 seconds. Determine the roll speed, S_{act}, using the following equation:

$$S_{act} = \frac{f \cdot d_{roll} \cdot \pi}{n} \qquad \text{Eq. 1066.135-1}$$

Where:

f = frequency of the dynamometer speed sensing device, in hr^{-1}, accurate to at least four significant figures.

d_{roll} = nominal roll diameter, in km, accurate to the nearest 0.01 mm, consistent with § 1066.125(d).

n = the number of pulses per revolution from the dynamometer roll speed sensor.

Where:

$f = 2.9318\ \text{Hz} = 2.9318\ s^{-1} = 10{,}554\ hr^{-1}$

$d_{roll} = 914.40\ \text{mm} = 914.40 \cdot 10^{-6}\ \text{km}$

n = 1 pulse/rev

$$S_{act} = \frac{10554 \cdot 904.40 \cdot 10^{-6} \cdot \pi}{1}$$

S_{act} = 29.986 kph

(ii) Compare the calculated roll speed, S_{act}, to the corresponding speed set point, S_{ref}, to determine a value for speed error, S_{error}, using the following equation:

$$S_{error} = S_{act} - S_{ref} \qquad \text{Eq. 1066.135-2}$$

Where:

S_{act} = 29.986 kph

S_{ref} = 30.000 kph

$S_{error} = 29.986 - 30.000 = -0.014$ kph

(2) *Frequency method.* Use the method described in this paragraph (c)(2) only if the dynamometer does not have a readily available output signal for speed sensing. Install a single piece of tape in the shape of an arrowhead on the surface of the dynamometer roll near the outer edge. Put a reference mark on the deck plate in line with the arrow. Install a stroboscope or photo tachometer on the deck plate and direct the flash toward the tape on the roll. The stroboscope or photo tachometer must be calibrated according to the instrument manufacturer's instructions and be capable of measuring with enough accuracy to perform the procedure as specified in this paragraph (c)(2). Determine the speed error as follows:

(i) Set the dynamometer to speed control mode. Set the dynamometer speed to a value between 15 kph and the maximum speed expected during testing. Tune the stroboscope or photo tachometer until the signal matches the dynamometer roll speed. Record the frequency. Determine the roll speed, y_{act}, using Equation 1066.135–1, using the stroboscope or photo tachometer's frequency for *f*.

(ii) Compare the calculated roll speed, y_{act}, to the corresponding speed set point, y_{ref}, to determine a value for speed error, y_{error}, using Equation 1066.135–2.

(d) *Performance evaluation.* The speed error determined in paragraph (c) of this section may not exceed ±0.050 mph or ±0.080 kph.

§ 1066.140 Torque transducer verification and calibration.

Calibrate torque-measurement systems as described in 40 CFR 1065.310.

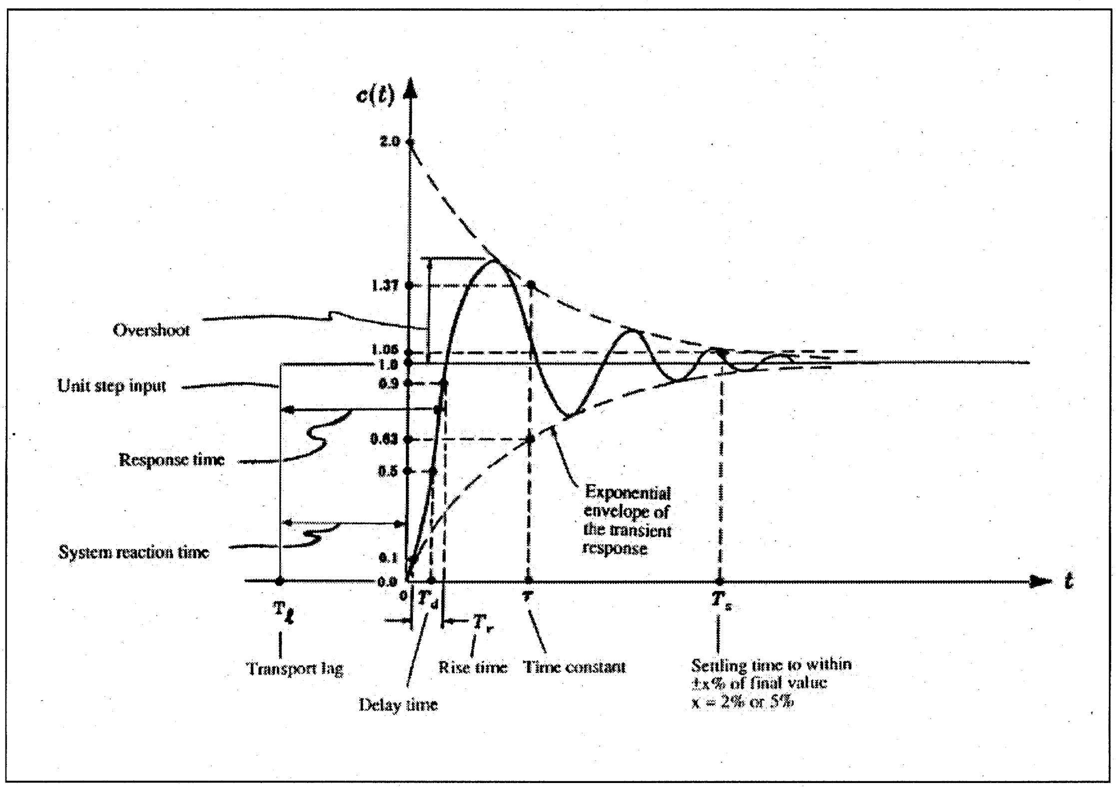
§ 1066.145 Response time verification.

(a) *Overview.* This section describes how to verify the dynamometer's response time.

(b) *Scope and frequency.* Perform this verification upon initial installation and after major maintenance.

(c) *Procedure.* Use the dynamometer's automated process to verify response time. Perform this test at two different inertia settings corresponding approximately to the minimum and maximum vehicle weights you expect to test. Use good engineering judgment to select road load coefficients representing vehicles of the appropriate weight. Determine the dynamometer's settling response time based on the point at which there are no measured results more than 10% above or below the final equilibrium value, as illustrated in Figure 1 of this section. The observed settling response time must be less than 100 milliseconds for each inertia setting.

Figure 1 of § 1066.145—Example of a settling response time diagram.



§ 1066.150 Base inertia verification.

(a) *Overview.* This section describes how to verify the dynamometer's base inertia.

(b) *Scope and frequency.* Perform this verification upon initial installation and after major maintenance.

(c) *Procedure.* Verify the base inertia using the following procedure:

(1) Warm up the dynamometer according to the dynamometer manufacturer's instructions. Set the dynamometer's road load inertia to zero and motor the rolls to 5 mph. Apply a constant force to accelerate the roll at a nominal rate of 1 mph/s. Measure the elapsed time to accelerate from 10 to 40 mph, noting the corresponding speed and time points to the nearest 0.01 mph and 0.01 s. Also determine average force over the measurement interval.

(2) Starting from a steady roll speed of 45 mph, apply a constant force to the roll to decelerate the roll at a nominal rate of 1 mph/s. Measure the elapsed time to decelerate from 40 to 10 mph, noting the corresponding speed and time points to the nearest 0.01 mph and 0.01 s. Also determine average force over the measurement interval.

(3) Repeat the steps in paragraphs (c)(1) and (2) of this section for a total of five sets of results at the nominal acceleration rate and the nominal deceleration rate.

(4) Use good engineering judgment to select two additional acceleration and deceleration rates that cover the middle and upper rates expected during testing. Repeat the steps in paragraphs (c)(1) through (3) of this section at each of these additional acceleration and deceleration rates.

(5) Determine the base inertia, I_b, for each measurement interval using the following equation:

$$I_{\mathrm{b}} = \frac{F}{\left|\dfrac{S_{\mathrm{final}} - S_{\mathrm{initial}}}{\Delta t}\right|} \qquad \text{Eq. 1066.150-1}$$

Where:

F = average dynamometer force over the measurement interval as measured by the dynamometer, in ft·lbm/s².

S_{final} = roll surface speed at the end of the measurement interval to the nearest 0.01 mph.

S_{initial} = roll surface speed at the start of the measurement interval to the nearest 0.01 mph.

Δt = elapsed time during the measurement interval to the nearest 0.01 s.

Where:

F = 1.500 lbf = 48.26 ft·lbm/s²

S_{final} = 40.00 mph = 58.67 ft/s

S_{initial} = 10.00 mph = 14.67 ft/s

Δt = 30.00 s

$$I_{\mathrm{b}} = \frac{48.26}{\left|\dfrac{58.67 - 14.67}{30.00}\right|}$$

I_{b} = 32.90 lbm

(6) Determine the arithmetic mean value of base inertia from the five measurements at each acceleration and deceleration rate. Calculate these six mean values as described in 40 CFR 1065.602(b).

(7) Calculate the base inertia error, I_{berror}, for each measured base inertia, I_{b}, by comparing it to the manufacturer's stated base inertia, I_{bref}, using the following equation:

$$I_{\mathrm{berror}} = \frac{I_{\mathrm{bref}} - I_{\mathrm{bact}}}{I_{\mathrm{bref}}} \cdot 100\ \% \qquad \text{Eq. 1066.150-2}$$

Where:

I_{bref} = 32.96 lbm

I_{bact} = 33.01 lbm

$$I_{\mathrm{berror}} = \frac{32.96 - 33.01}{32.96} \cdot 100\ \%$$

I_{berror} = −0.15%

(8) Calculate the inertia error for each mean value of base inertia from paragraph (c)(6) of this section. Use Equation 1066.165–2, substituting the mean base inertias associated with each acceleration and deceleration rate for the individual base inertias.

(d) *Performance evaluation.* The dynamometer must meet the following specifications to be used for testing under this part:

(1) The base inertia error determined under paragraph (c)(7) of this section may not exceed ±0.50% relative to any individual value.

(2) The base inertia error determined under paragraph (c)(8) of this section may not exceed ±0.20% relative to any mean value.

§ 1066.155 Parasitic loss verification.

(a) *Overview.* Verify and correct the dynamometer's parasitic loss. This procedure determines the dynamometer's internal losses that it must overcome to simulate road load. These losses are characterized in a parasitic loss curve that the dynamometer uses to apply compensating forces to maintain the desired road load force at the roll surface.

(b) *Scope and frequency.* Perform this verification upon initial installation, within 7 days of testing, and after major maintenance.

(c) *Procedure.* Perform this verification by following the dynamometer manufacturer's specifications to establish a parasitic loss curve, taking data at fixed speed intervals to cover the range of vehicle speeds that will occur during testing. You may zero the load cell at the selected speed if that improves your ability to determine the parasitic loss. Parasitic loss forces may never be negative. Note that the torque transducers must be zeroed and spanned prior to performing this procedure.

(d) *Performance evaluation.* In some cases, the dynamometer automatically updates the parasitic loss curve for further testing. If this is not the case, compare the new parasitic loss curve to the original parasitic loss curve from the dynamometer manufacturer or the most recent parasitic loss curve you programmed into the dynamometer. You may reprogram the dynamometer to accept the new curve in all cases, and you must reprogram the dynamometer if any point on the new curve departs from the earlier curve by more than ±0.5 lbf.

§ 1066.160 Parasitic friction compensation evaluation.

(a) *Overview.* This section describes how to verify the accuracy of the dynamometer's friction compensation.

(b) *Scope and frequency.* Perform this verification upon initial installation, within 7 days before testing, and after major maintenance. Note that this procedure relies on proper verification or calibration of speed and torque, as described in §§ 1066.135 and 1066.140. You must also first verify the dynamometer's parasitic loss curve as specified in § 1066.155.

(c) *Procedure.* Use the following procedure to verify the accuracy of the dynamometer's friction compensation:

(1) Warm up the dynamometer as specified by the dynamometer manufacturer.

(2) Perform a torque verification as specified by the dynamometer manufacturer. For torque verifications relying on shunt procedures, if the results do not conform to specifications, recalibrate the dynamometer using NIST-traceable standards as appropriate until the dynamometer passes the torque verification. Do not change the dynamometer's base inertia to pass the torque verification.

(3) Set the dynamometer inertia to the base inertia with the road load coefficients A, B, and C set to 0. Set the dynamometer to speed-control mode

with a target speed of 10 mph or a higher speed recommended by the dynamometer manufacturer. Once the speed stabilizes at the target speed, switch the dynamometer from speed control to torque control and allow the roll to coast for 60 seconds. Record the initial and final speeds and the corresponding start and stop times. If friction compensation is executed perfectly, there will be no change in speed during the measurement interval.

(4) Calculate the friction compensation error, FC_{error}, using the following equation:

$$FC_{error} = \frac{I}{2 \cdot t} \cdot \left(S_{final}^2 - S_{init}^2\right) \qquad \text{Eq. 1066.160-5}$$

Where:

I = dynamometer inertia setting, in lbf·s²/ft.
t = duration of the measurement interval, accurate to at least 0.01 s.
S_{final} = the roll speed corresponding to the end of the measurement interval, accurate to at least 0.1 mph.
S_{init} = the roll speed corresponding to the start of the measurement interval, accurate to at least 0.1 mph.

Where:

I = 2000 lbm = 62.16 lbf· s²/ft
t = 60.0 s
S_{final} = 9.2 mph = 13.5 ft/s
S_{init} = 10.0 mph = 14.7 ft/s

$$FC_{error} = \frac{62.16}{2 \cdot 60.00} \cdot \left(13.5^2 - 14.7^2\right)$$

FC_{error} = -16.5 ft·lbf/s = -0.031 hp

(5) The friction compensation error may not exceed ±0.10 hp.

§ 1066.165 Acceleration and deceleration verification.

(a) *Overview.* This section describes how to verify the dynamometer's ability to achieve targeted acceleration and deceleration rates. Paragraph (c) of this section describes how this verification applies when the dynamometer is programmed directly for a specific acceleration or deceleration rate. Paragraph (d) of this section describes how this verification applies when the dynamometer is programmed with a calculated force to achieve a targeted acceleration or deceleration rate.

(b) *Scope and frequency.* Perform this verification upon initial installation and after major maintenance. Perform this verification upon initial installation and after major maintenance.

(c) *Verification of acceleration and deceleration rates.* Activate the dynamometer's function generator for measuring roll revolution frequency. If the dynamometer has no such function generator, set up a properly calibrated external function generator consistent with the verification described in this paragraph (c). Use the function generator to determine actual acceleration and deceleration rates as the dynamometer traverses speeds between 10 and 40 mph at various nominal acceleration and deceleration rates. Verify the dynamometer's acceleration and deceleration rates as follows:

(1) Set up start and stop frequencies specific to your dynamometer by identifying the roll-revolution frequency, f, in revolutions pre second (or Hz) corresponding to 10 mph and 40 mph vehicle speeds, accurate to at least four significant figures, using the following equation:

$$f = \frac{S \cdot n}{d_{roll} \cdot \pi} \qquad \text{Eq. 1066.165-1}$$

Where:

S = the target roll speed, in inches per second (corresponding to drive speeds of 10 mph or 40 mph).
n = the number of pulses from the dynamometer's roll-speed sensor per roll revolution.
d_{roll} = roll diameter, in inches.

(2) Program the dynamometer to accelerate the roll at a nominal rate of 1 mph/s from 10 mph to 40 mph. Measure the elapsed time to reach the target speed, to the nearest 0.01 s. Repeat this measurement for a total of five runs. Determine the actual acceleration rate for each run, aact, using the following equation:

$$a_{act} = \frac{S_{final} - S_{init}}{t} \qquad \text{Eq. 1066.165-2}$$

Where:

a_{act} = acceleration rate (decelerations have negative values).
S_{final} = the target value for the final roll speed.
S_{init} = the setpoint value for the initial roll speed.
t = time to accelerate from S_{init} to S_{final}.

Where:

S_{inal} = 40 mph
S_{init} = 10 mph
t = 30.003 s

$$a_{act} = \frac{40.00 - 10.00}{30.03}$$

a_{act} = 0.999 mph/s

(3) Program the dynamometer to decelerate the roll at a nominal rate of 1 mph/s from 40 mph to 10 mph. Measure the elapsed time to reach the target speed, to the nearest 0.01 s. Repeat this measurement for a total of five runs. Determine the actual acceleration rate, a_{act}, using Equation 1066.165–2

(4) Repeat the steps in paragraphs (c)(2) and (3) of this section for additional acceleration and deceleration rates in 1 mph/s increments up to and including one increment above the maximum acceleration rate expected during testing. Average the five repeat runs to calculate a mean acceleration rate, $a\bar{a}_{act}$, each setting.

(5) Compare each mean acceleration rate, $a\bar{a}_{act}$, to the corresponding nominal acceleration rate, aref, to determine values for acceleration error, aerror, using the following equation:

$$a_{error} = \frac{\bar{a}_{act} - a_{ref}}{a_{ref}} \cdot 100\ \% \qquad \text{Eq. 1066.165-4}$$

Where:

$\bar{a}_{act}$ =0.999 mph/s
a_{ref} = 1 mph/s
a_{error} = -0.100%

(d) V*erification of forces for controlling acceleration and deceleration.* Program the dynamometer with a calculated force value and determine actual acceleration and deceleration rates as the dynamometer traverses speeds between 10 and 40 mph at various nominal acceleration and deceleration rates. Verify the dynamometer's ability to achieve certain acceleration and deceleration rates with a given force as follows:

(1) Calculate the force setting, F, using the following equation:

$$F = I_b \cdot |a| \qquad \text{Eq. 1066.165-5}$$

Where:

I_b = the dynamometer manufacturer's stated base inertia, in lbf·s²/ft.
a = nominal acceleration rate, in ft/s².

Where:

I_b = 2967 lbm = 92.217 lbf· s2/ft
a = 1 mph/s = 1.4667 ft/s²
F = 135.25 lbf

(2) Set the dynamometer to road-load mode and program it with a calculated force to accelerate the roll at a nominal rate of 1 mph/s from 10 mph to 40 mph. Measure the elapsed time to reach the target speed, to the nearest 0.01 s. Repeat this measurement for a total of five runs. Determine the actual acceleration rate, a_{act}, for each run using Equation 1066.165–2. Repeat this step to determine measured "negative acceleration" rates using a calculated force to decelerate the roll at a nominal rate of 1 mph/s from 40 mph to 10 mph. Average the five repeat runs to calculate a mean acceleration rate, $a\bar{a}_{act}$, at each setting.

(3) Repeat the steps in paragraph (d)(2) of this section for additional acceleration and deceleration rates as specified in paragraph (c)(4) of this section.

(4) Compare each mean acceleration rate, $a\bar{a}_{act}$, to the corresponding nominal acceleration rate, a_{ref}, to determine values for acceleration error, a_{error}, using Equation 1066.165–4

(e) *Performance evaluation.* The acceleration error from paragraphs (c)(5) and (d)(4) of this section may not exceed ± 1.0%.

§ 1066.170 Unloaded coastdown verification.

(a) *Overview.* Use force measurements to verify the dynamometer's settings based on coastdown procedures.

(b) *Scope and frequency.* Perform this verification upon initial installation, within 7 days of testing, and after major maintenance.

(c) *Procedure.* This procedure verifies dynamometer's settings derived from coastdowns testing. For dynamometers that have an automated process for this procedure, perform this evaluation by setting the initial speed, final speed, inertial, and road load coefficients as required for each test, using good engineering judgment to ensure that these values properly represent in-use operation. Use the following procedure if your dynamometer does not perform this verification with have an automated process:

(1) Warm up the dynamometer as specified by the dynamometer manufacturer.

(2) With the dynamometer in coastdown mode, set the dynamometer inertia for the smallest vehicle weight that you expect to test and set A, B, and C road load coefficients to values typical of those used during testing. Program the dynamometer to operate at 10 mph. Perform a coastdown two times at this speed setting. Repeat these coastdown steps in 10 mph increments up to and including one increment above the maximum speed expected during testing. You may stop the verification before reaching 0 mph, with any appropriate adjustments in calculating the results.

(3) Repeat the steps in paragraph (c)(2) of this section with the dynamometer inertia set for the largest vehicle weight that you expect to test.

(4) Determine the average coastdown force, F, for each speed and inertia setting using the following equation:

$$F = \frac{I \cdot S_{si}}{t} \qquad \text{Eq. 1066.170-1}$$

Where:

F = the average force measured during the coastdown for each speed and inertia setting, expressed in lbf · s²/ft and rounded to four significant figures.
I = the dynamometer's inertia setting, in lbf · s²/ft.
S_{si} = the speed setting at the start of the coastdown, expressed in ft/s and rounded to four significant figures.
t = coastdown time for each speed and inertia setting, accurate to at least 0.01 s.

Where:

I = 2000 lbm = 65.17 lbf · s²/ft
S_{si} = 10 mph = 14.66 ft/s
t = 5.00 s

$$F = \frac{65.17 \cdot 14.66}{5.00}$$

F = 191 lbf

(5) Calculate the target value of coastdown force, F_{ref}, based on the applicable dynamometer parameters for each speed and inertia setting.

(6) Compare the mean value of the coastdown force measured for each speed and inertia setting, $\bar{F}_{act}$, to the corresponding F_{ref} to determine values for coastdown force error, F_{error}, using the following equation:

$$F_{error} = \frac{\bar{F}_{act} - F_{ref}}{F_{ref}} \cdot 100\ \% \qquad \text{Eq. 1066.170-2}$$

Where:

F_{ref} = 192 lbf
$\bar{F}_{act}$ = 191 lbf

$$F_{error} = \frac{191 - 192}{192} \cdot 100\ \%$$

F_{error} = −0.5%

(7) Calculate the maximum allowable error for all speed and inertia settings as follows:

$F_{errormax}$ = Max [±1.0% or (2.2 lbf/F_{ref}) · 100%]

§ 1066.180 Driver's aid.

Use good engineering judgment to provide a driver's aid that facilitates compliance with the requirements of § 1066.330.

Subpart C—Coastdown

§ 1066.201 Overview of coastdown procedures.

(a) The coastdown procedures described in this subpart are used to determine the load coefficients (A, B, and C) for the simulated road load equation in § 1066.110(d)(3).

(b) The general procedure for performing coastdown tests and calculating load coefficients is described in SAE J2263 (incorporated by reference in § 1066.710). This subpart specifies certain deviations from SAE J2263 for certain applications.

(c) Use good engineering judgment for all aspects of coastdown testing. For example, minimize the effects of grade by performing coastdown testing on reasonably level surfaces and determining coefficients based on average values from vehicle operation in opposite directions over the course.

§ 1066.210 Coastdown procedures for heavy-duty vehicles.

This section describes coastdown procedures that are unique to heavy-duty motor vehicles.

(a) Determine load coefficients by performing a minimum of 20 coastdown runs (10 in each direction).

(b) Follow the provisions of SAE J2263 (incorporated by reference in § 1066.710), except as described in this paragraph (b). The terms and variables identified in this paragraph (b) have the meaning given in SAE J2263 unless specified otherwise.

(1) You are not required to reach the top speed specified in Section 9.3 of SAE J2263, as long as your top speed for each run is no lower than 100 km/h (62.2 mph).

(2) Section 9.3.1 of SAE J2263 allows split runs, but we recommend whole runs. If you use split runs, analyze them separately but count them together with respect to the minimum number of runs required.

(3) You may perform consecutive runs in a single direction, followed by consecutive runs in the opposite direction, consistent with good engineering judgment. Harmonize starting and stopping points to the extent practicable to allow runs to be paired.

(4) Section 12.1 of SAE J2263 allows determination of calibration coefficients from calibration runs conducted at a constant 50 mph in each road direction.

(i) We recommend using the following equation to correct relative wind speed (Sr) in calibration runs:

$$S_{\mathrm{r,i}} = \frac{1}{2} S_{\mathrm{r,meas,dir,i}} \sum_{\mathrm{dir}} \left[\frac{1}{n_{\mathrm{i,dir}}} \sum_{\mathrm{i}} \left(\frac{S_{\mathrm{dir,i}}}{S_{\mathrm{r,meas,dir,i}}} \right) \right] \qquad \text{Eq. 1066.210-1}$$

(ii) We recommend using the following equation to correct yaw angle (*Y*) in coastdowns:

$$Y_{\mathrm{i}} = Y_{\mathrm{meas,i}} - \frac{1}{2} \sum_{\mathrm{dir}} \left[\frac{1}{n_{\mathrm{i,dir}}} \sum_{\mathrm{i=1}}^{25} Y_{\mathrm{meas,dir,i}} \right] \qquad \text{Eq. 1066.210-2}$$

(5) Use the following equation of motion instead of the equation specified in SAE J2263:

$$-M_{\mathrm{e}} \frac{\Delta S}{\Delta t} = A_{\mathrm{m}} + D_{\mathrm{a}} \cdot S_{\mathrm{r}}^2 + E \cdot S_{\mathrm{r}}^2 \cdot Y^2 \pm M \cdot g \left(\frac{\Delta h}{\Delta s} \right) \qquad \text{Eq. 1066.210-3}$$

(i) Determine A_m, D_a, and E using a mixed model technique, with the run being the random effect.

(ii) Determine the A, B, and C coefficients identified in § 1066.110 as follows:

$A = A_m$

$B = 0$

$C = D_a$

(iii) Consistent with good engineering judgment, set E equal to zero if wind direction effects are not statistically significant. Use the following simplified equation of motion if wind direction effects are not statistically significant and grade effects are negligible:

$$-M_{\mathrm{e}} \frac{\Delta S}{\Delta t} = A_{\mathrm{m}} + D_{\mathrm{a}} \cdot S_{\mathrm{r}}^2 \qquad \text{Eq. 1066.210-4}$$

Subpart D—Vehicle Preparation and Running a Test

§ 1066.301 Overview.

(a) Use the procedures detailed in this subpart to measure vehicle emissions over a specified drive schedule. This subpart describes how to:

(1) Determine road load power, test weight, and inertia class.

(2) Prepare the vehicle, equipment, and measurement instruments for an emission test.

(3) Perform pre-test procedures to verify proper operation of certain equipment and analyzers and to prepare them for testing.

(4) Record pre-test data.

(5) Sample emissions.

(6) Record post-test data.

(7) Perform post-test procedures to verify proper operation of certain equipment and analyzers.

(8) Weigh PM samples.

(b) An emission test generally consists of measuring emissions and other parameters while a vehicle follows the drive schedules specified in the standard-setting part. There are two general types of test cycles:

(1) *Transient cycles*. Transient test cycles are typically specified in the standard-setting part as a second-by-second sequence of vehicle speed commands. Operate a vehicle over a transient cycle such that the speed follows the target values. Proportionally sample emissions and other parameters and use the calculations in 40 CFR part 86, subpart B, or 40 CFR part 1065, subpart G, to calculate emissions. The standard-setting part may specify three types of transient testing based on the approach to starting the measurement, as follows:

(i) A cold-start transient cycle where you start to measure emissions just before starting an engine that has not been warmed up.

(ii) A hot-start transient cycle where you start to measure emissions just before starting a warmed-up engine.

(iii) A hot running transient cycle where you start to measure emissions after an engine is started, warmed up, and running.

(2) *Cruise cycles*. Cruise test cycles are typically specified in the standard-

setting part as a discrete operating point that has a single speed command.

(i) Start a cruise cycle as a hot running test, where you start to measure emissions after the engine is started and warmed up and the vehicle is running at the target test speed.

(ii) Sample emissions and other parameters for the cruise cycle in the same manner as a transient cycle, with the exception that reference speed value is constant. Record instantaneous and mean speed values over the cycle.

§ 1066.304 Road load power and test weight determination.

To determine road load power and test weight, follow SAE J2263 and SAE J2264 (incorporated by reference in § 1066.710), with the following exceptions:

(a) *Test weight.* The rotational inertia of drive-axle and nondrive-axle components that rotate with the wheels is expressed as additional "linear" mass. For Class 7 combination and Class 8 heavy-duty vehicles, without dual drive tires (or other driveline components which are likely to increase real rotational inertia to greater than 1.5% per axle) and if the actual effective mass of rotating components is unknown, the effective mass of all rotating components may be estimated as 4.0% of the vehicle test mass.

(b) [Reserved]

§ 1066.307 Vehicle preparation and preconditioning.

This section describes steps to take before measuring exhaust emissions for those vehicles that are subject to evaporative or refueling emission tests as specified in subpart F of this part. Other preliminary procedures may apply as specified in the standard-setting part.

(a) Prepare the vehicle for testing as described in 40 CFR 86.131–00.

(b) If testing will include measurement of refueling emissions, perform the vehicle preconditioning steps as described in 40 CFR 86.153–98. Otherwise, perform the vehicle preconditioning steps as described in 40 CFR 86.132–00.

§ 1066.310 Dynamometer test procedure.

(a) Dynamometer testing may consist of multiple drive cycles with both cold-start and hot-start portions, including prescribed soak times before each test phase. *See* the standard-setting part for test cycles and soak times for the appropriate vehicle category. A test phase consists of engine startup (with accessories operated according to the standard-setting part), operation over the drive cycle, and engine shutdown.

(b) During dynamometer operation, position a road-speed modulated cooling fan that appropriately directs cooling air to the vehicle. This generally requires squarely positioning the fan within 30 centimeters of the front of the vehicle and directing the airflow to the vehicle's radiator. Use a fan system that achieves a linear speed of cooling air at the blower outlet that is within ±3 mph of the corresponding roll speed when vehicle speeds are between 5 to 30 mph, and within ±10 mph of the corresponding roll speed at higher vehicle speeds. The fan must provide no cooling air for vehicle speeds below 5 mph, unless we approve your request to provide cooling during low-speed operation based on a demonstration that this is appropriate to simulate the cooling experienced by in-use vehicles. If the cooling specifications in this paragraph (b) are impractical for special vehicle designs, such as vehicles with rear-mounted engines, you may arrange for an alternative fan configuration that allows for proper simulation of vehicle cooling during in-use operation.

(c) Record the vehicle's speed trace based on the time and speed data from the dynamometer. Record speed to at least the nearest 0.1 mph and time to at least the nearest 0.1 s.

(d) You may perform practice runs to for operating the vehicle and the dynamometer controls to meet the driving tolerances specified in § 1066.330 or adjust the emission sampling equipment. Verify that accelerator pedal allows for enough control to closely follow the prescribed driving schedule. You may not measure emissions during a practice run.

(e) Inflate the drive wheel tires according to the vehicle manufacturer's specifications. The drive wheels' tire pressure must be the same for dynamometer operation and for coastdown procedures for determining road load coefficients. Report these tire pressure values with the test results.

(f) Warm up the dynamometer as recommended by the dynamometer manufacturer.

(g) Following the test, determine the actual driving distance by counting the number of dynamometer roll or shaft revolutions, or by integrating speed over the course of testing from a high-resolution encoder system.

(h) Use good engineering judgment to test four-wheel drive and all-wheel drive vehicles. This may involve testing on a dynamometer with a separate dynamometer roll for each drive axle. This may also involve operation on a single roll, which would require disengaging the second set of drive wheels, either with a switch available to the driver or by some other means; however, operating such a vehicle on a single roll may occur only if this does not decrease emissions or energy consumption relative to normal in-use operation.

§ 1066.320 Pre-test verification procedures and pre-test data collection.

(a) Follow the procedures for PM sample preconditioning and tare weighing as described in 40 CFR 1065.590 if your engine must comply with a PM standard.

(b) Unless the standard-setting part specifies different tolerances, verify at some point before the test that ambient conditions are within the tolerances specified in this paragraph (b). For purposes of this paragraph (b), "before the test" means any time from a point just prior to engine starting (excluding engine restarts) to the point at which emission sampling begins.

(1) Ambient temperature must be (20 to 30) °C. *See* § 1066.330(m) for circumstances under which ambient temperatures must remain within this range during the test.

(2) Atmospheric pressure must be (80.000 to 103.325) kPa. You are not required to verify atmospheric pressure prior to a hot-start test interval for testing that also includes a cold start.

(3) Dilution air conditions must meet the specifications in 40 CFR 1065.140, except in cases where you preheat your CVS before a cold-start test. We recommend verifying dilution air conditions just before starting each test phase.

(c) You may test vehicles at any intake-air humidity and we may test vehicles at any intake-air humidity.

(d) You may perform a final calibration of the proportional-flow control systems, which may include performing practice runs.

(e) You may perform the following recommended procedure to precondition sampling systems:

(1) Operate the vehicle over the test cycle.

(2) Operate any dilution systems at their expected flow rates. Prevent aqueous condensation in the dilution systems.

(3) Operate any PM sampling systems at their expected flow rates.

(4) Sample PM for at least 10 min using any sample media. You may change sample media during preconditioning. You must discard preconditioning samples without weighing them.

(5) You may purge any gaseous sampling systems during preconditioning.

(6) You may conduct calibrations or verifications on any idle equipment or analyzers during preconditioning.

(7) Proceed with the test sequence described in § 1066.330.

(f) Verify the amount of nonmethane contamination in the exhaust and background HC sampling systems within 8 hours before the start of the first test drive cycle for each individual vehicle tested as described in 40 CFR 1065.515(g).

§ 1066.325 Engine starting and restarting.

(a) Start the vehicle's engine as follows:

(1) At the beginning of the test cycle, start the engine according to the procedure you describe in your owners manual.

(2) Place the transmission in gear as described by the test cycle in the standard-setting part. During idle operation, you may apply the brakes if necessary to keep the drive wheels from turning.

(b) If the vehicle does not start after your recommended maximum cranking time, wait and restart cranking according to your recommended practice. If you don't recommend such a cranking procedure, stop cranking after 10 seconds, wait for 10 seconds, then start cranking again for up to 10 seconds. You may repeat this for up to three start attempts. If the vehicle does not start after three attempts, you must determine and record the reason for failure to start. Shut off sampling systems and either turn the CVS off, or disconnect the exhaust tube from the tailpipe during the diagnostic period. Reschedule the vehicle for testing from a cold start.

(c) Repeat the recommended starting procedure if the engine has a "false start".

(d) Take the following steps if the engine stalls:

(1) If the engine stalls during an idle period, restart the engine immediately and continue the test. If you cannot restart the engine soon enough to allow the vehicle to follow the next acceleration, stop the driving schedule indicator and reactivate it when the vehicle restarts.

(2) If the engine stalls during operation other than idle, stop the driving schedule indicator, restart the engine, accelerate to the speed required at that point in the driving schedule, reactivate the driving schedule indicator, and continue the test.

(3) Void the test if the vehicle will not restart within one minute. If this happens, remove the vehicle from the dynamometer, take corrective action, and reschedule the vehicle for testing. Record the reason for the malfunction (if determined) and any corrective action. *See* the standard-setting part for instructions about reporting these malfunctions.

§ 1066.330 Performing emission tests.

The overall test consists of prescribed sequences of fueling, parking, and operating test conditions.

(a) Vehicles are tested for criteria pollutants and greenhouse gas emissions as described in the standard-setting part.

(b) Take the following steps before emission sampling begins:

(1) For batch sampling, connect clean storage media, such as evacuated bags or tare-weighed filters.

(2) Start all measurement instruments according to the instrument manufacturer's instructions and using good engineering judgment.

(3) Start dilution systems, sample pumps, and the data-collection system.

(4) Pre-heat or pre-cool heat exchangers in the sampling system to within their operating temperature tolerances for a test.

(5) Allow heated or cooled components such as sample lines, filters, chillers, and pumps to stabilize at their operating temperatures.

(6) Verify that there are no significant vacuum-side leaks according to 40 CFR 1065.345.

(7) Adjust the sample flow rates to desired levels, using bypass flow, if desired.

(8) Zero or re-zero any electronic integrating devices, before the start of any test interval.

(9) Select gas analyzer ranges. You may automatically or manually switch gas analyzer ranges during a test only if switching is performed by changing the span over which the digital resolution of the instrument is applied. During a test you may not switch the gains of an analyzer's analog operational amplifier(s).

(10) Zero and span all continuous gas analyzers using NIST-traceable gases that meet the specifications of 40 CFR 1065.750. Span FID analyzers on a carbon number basis of one (1), C_1. For example, if you use a C_3H_8 span gas of concentration 200 µmol/mol, span the FID to respond with a value of 600 µmol/mol. Span FID analyzers consistent with the determination of their respective response factors, *RF*, and penetration fractions, *PF*, according to 40 CFR 1065.365.

(11) We recommend that you verify gas analyzer responses after zeroing and spanning by sampling a calibration gas that has a concentration near one-half of the span gas concentration. Based on the results and good engineering judgment, you may decide whether or not to re-zero, re-span, or re-calibrate a gas analyzer before starting a test.

(12) If you correct for dilution air background concentrations of associated engine exhaust constituents, start measuring (*i.e.* sampling) and recording background concentrations.

(13) Turn on cooling fans immediately prior to the start of the test.

(c) Operate vehicles during testing as follows:

(1) Where we do not give specific instructions, operate the vehicle according to your recommendations in the owners manual, unless those recommendations are unrepresentative of what may reasonably be expected for in-use operation.

(2) If vehicles have features that preclude dynamometer testing, modify these features as necessary to allow testing, consistent with good engineering judgment.

(3) Operate vehicles during idle as follows:

(i) For a vehicle with an automatic transmission, operate at idle with the transmission in "Drive" with the wheels braked, except that you may shift to "Neutral" for the first idle period and for any idle period longer than one minute. If you put the vehicle in "Neutral" during an idle, you must shift the vehicle into "Drive" with the wheels braked at least 5 seconds before the end of the idle period.

(ii) For a vehicle with a manual transmission, operate at idle with the transmission in gear with the clutch disengaged, except that you may shift to "Neutral" with the clutch disengaged for the first idle period and for any idle period longer than one minute. If you put the vehicle in "Neutral" during idle, you must shift to first gear with the clutch disengaged at least 5 seconds before the end of the idle period.

(4) If the vehicle cannot accelerate at the specified rate, operate it at maximum available power until the vehicle speed reaches the value prescribed for that time in the driving schedule.

(5) Decelerate without changing gears, using the brakes or accelerator pedal as necessary to maintain the desired speed. Keep the clutch engaged on manual transmission vehicles and do not change gears after the end of the acceleration event. Depress manual transmission clutches when the speed drops below 15 mph (24.1 km/h), when engine roughness is evident, or when engine stalling is imminent.

(6) For test vehicles equipped with manual transmissions, shift gears in a way that represents reasonable shift

patterns for in-use operation, considering vehicle speed, engine speed, and any other relevant variables. You may recommend a shift schedule in your owners manual that differs from your shift schedule during testing as long as you include both shift schedules in your application for certification. In this case, we may use the shift schedule you describe in your owners manual.

(d) *See* the standard-setting part for drive schedules. These are defined by a smooth trace drawn through the specified speed vs. time sequence.

(e) The driver must attempt to follow the target schedule as closely as possible, consistent with the specifications in paragraph (b) of this section. Instantaneous speeds must stay within the following tolerances:

(1) The upper limit is 2.0 mph higher than the highest point on the trace within 1.0 s of the given point in time.

(2) The lower limit is 2.0 mph lower than the lowest point on the trace within 1.0 second of the given time.

(3) The same limits apply For vehicle preconditioning, except that the upper and lower limits for speed values are ±4.0 mph.

(4) Void the test if you do not maintain speed values as specified in this paragraph (e)(4). Speed variations (such as may occur during gear changes or braking spikes) may occur as follows, provided that such variations are clearly documented, including the time and speed values and the reason for deviation:

(i) Speed variations greater than the specified limits are acceptable for up to 2.0 seconds on any occasion.

(ii) For vehicle preconditioning, up to three additional occurrences of speed variations outside the specified limits are acceptable for up to 15 seconds on any occasion.

(iii) For vehicles that are not able to maintain acceleration as specified in paragraph (b)(4) of this section, do not count the insufficient acceleration as being outside the specified limits.

(f) Figure 1 and Figure 2 of this section show the range of acceptable speed tolerances for typical points during testing. Figure 1 of this section is typical of portions of the speed curve that are increasing or decreasing throughout the 2-second time interval. Figure 2 of this section is typical of portions of the speed curve that include a maximum or minimum value.

Figure 1 of § 1066.330—Example of the allowable ranges for the driver's trace.

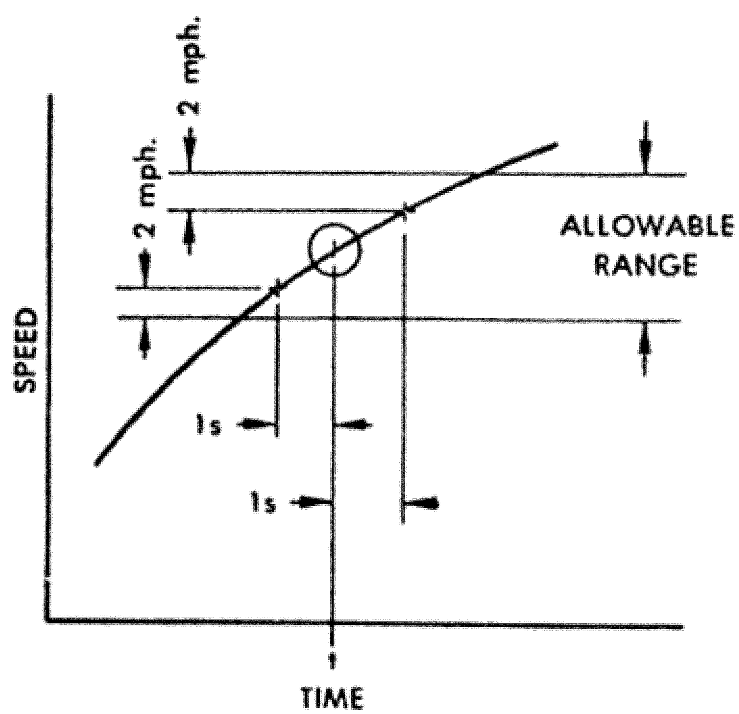
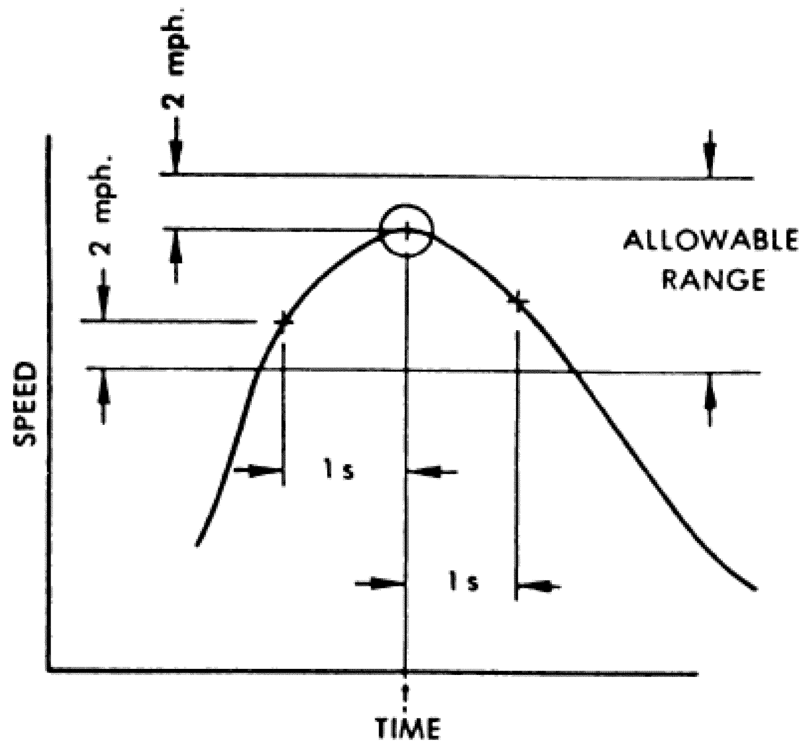


Figure 2 of § 1066.330---Example of the allowable ranges for the driver's trace.



(g) Start testing as follows:

(1) If a vehicle is already running and warmed up, and starting is not part of the test cycle, perform the following for the following types of test cycles:

(i) Transient test cycles. Control vehicle speeds to follow a drive schedule consisting of a series of idles, accelerations, cruises, and decelerations.

(ii) Cruise test cycles. Control the vehicle operation to match the speed of the first phase of the test cycle. Follow the instructions in the standard-setting part to determine how long to stabilize the vehicle during each phase, how long to sample emissions at each phase, and how to transition between phases.

(2) If engine starting is part of the test cycle, initiate data logging, sampling of exhaust gases, and integrating measured values before starting the engine. Initiate the driver's trace when the engine starts.

(h) At the end of each test interval, continue to operate all sampling and dilution systems to allow the response times to elapse. Then stop all sampling and recording, including the recording of background samples. Finally, stop any integrating devices and indicate the end of the duty cycle in the recorded data.

(i) Shut down the vehicle if it is part of the test cycle or if testing is complete.

(j) If testing involves engine shutdown followed by another test phase, start a timer for the vehicle soak when the engine shuts down.

(k) Take the following steps after emission sampling is complete:

(1) For any proportional batch sample, such as a bag sample or PM sample, verify that proportional sampling was maintained according to 40 CFR 1065.545. Void any samples that did not maintain proportional sampling according to specifications.

(2) Place any used PM samples into covered or sealed containers and return them to the PM-stabilization environment. Follow the PM sample post-conditioning and total weighing procedures in 40 CFR 1065.595.

(3) As soon as practical after the test cycle is complete, or optionally during the soak period if practical, perform the following:

(i) Drift check all continuous gas analyzers and zero and span all batch gas analyzers no later than 30 minutes after the test cycle is complete, or during the soak period if practical.

(ii) Analyze any conventional gaseous batch samples no later than 30 minutes after a test phase is complete, or during the soak period if practical.

(iii) Analyze background samples no later than 60 minutes after the test cycle is complete.

(iv) Analyze gaseous batch samples requiring off-line analysis, such as ethanol, no later than 30 minutes after the test cycle is complete.

(4) After quantifying exhaust gases, verify drift as follows:

(i) For batch and continuous gas analyzers, record the mean analyzer value after stabilizing a zero gas to the analyzer. Stabilization may include time to purge the analyzer of any sample gas, plus any additional time to account for analyzer response.

(ii) Record the mean analyzer value after stabilizing the span gas to the analyzer. Stabilization may include time to purge the analyzer of any sample gas, plus any additional time to account for analyzer response.

(iii) Use these data to validate and correct for drift as described in 40 CFR 1065.550.

(l) [Reserved]

(m) Measure and record ambient temperature and pressure. Also measure humidity, as required, such as for correcting NO_X emissions. For testing vehicles with the following engines, you must record ambient temperature continuously to verify that it remains within the temperature range specified in § 1066.320(b)(1) throughout the test:

(1) Air-cooled engines.

(2) Engines equipped with emission control devices that sense and respond to ambient temperature.

(3) Any other engine for which good engineering judgment indicates that this

is necessary to remain consistent with 40 CFR 1065.10(c)(1).

(n) Validate overall driver accuracy by comparing the expected power generated, based on measured vehicle speeds, to the theoretical power that would have been generated by driving exactly to the target trace. You may remove any vehicle speed points and corresponding target trace speed points based on insufficient engine power as allowed in paragraph (e)(5) of this section.

(1) Calculate the mean power demand at the wheels, P, based on the measured vehicle speed as follows:

$$\overline{P} = \frac{\sum_{i=1}^{N} S_i \cdot \left(\left(A + B \cdot S_i + C \cdot S_i^2 \right) + \left(\left(\frac{S_i - S_{i-1}}{t_i - t_{i-1}} \right) \cdot M_e \right) \right)}{N} \qquad \text{Eq. 1066.330-1}$$

Where:

i = An indexing variable that represents one recorded value of vehicle speed.

N = number of recorded speed values.

A, B, and C = the road load coefficients.

S_i = the measured vehicle speed at a given point in time, accurate to at least the nearest 0.01 mph. Convert speed values to ft/s in all cases except for the terms used with the B and C coefficients. Let S_i-1 = 0.

t_i = the measured vehicle speed at a given point in time, accurate to at least the nearest 0.01 s. Let t_i-1 = 0.

M_e = effective vehicle mass, accurate to at least the nearest 1 lbm, expressed in lbf · s²/ft. *See* § 1066.304(a).

Example:

S_0 = 0.00 mph = 0.00 ft/s

S_1 = 0.23 mph = 0.34 ft/s

S_2 = 0.47 mph = 0.69 ft/s

A = 69.2 lbf

B = -0.424 lbf/mph

C = 0.03089 lbf/mph ^{2}

$t_2 - t_1$ = 0.1 s (10 Hz)

$$\left(\frac{S_1 - S_0}{t_1 - t_0} \right) = \left(\frac{0.23 - 0}{0.100} \right) = 2.30 \text{ mph/s} = 3.37 \text{ ft/s}^2$$

$$\left(\frac{S_2 - S_1}{t_2 - t_1} \right) = \left(\frac{0.47 - 0.23}{0.10} \right) = 2.40 \text{ mph/s} = 3.52 \text{ ft/s}^2$$

M_e = 9800 lbm = 304.59 lbf·s²/ft

N = 6680

$$\overline{P} = \frac{\left(\begin{array}{l} \left(0.34 \cdot \left(\left(69.2 + (-0.424 \cdot 0.23) + 0.03089 \cdot 0.23^2 \right) + (3.37 \cdot 304.59) \right) \right) + \\ \left(0.69 \cdot \left(\left(69.2 + (-0.424 \cdot 0.47) + 0.03089 \cdot 0.47^2 \right) + (3.52 \cdot 304.59) \right) \right) + \\ \ldots + \left(S_{6680} \cdot \left(\left(69.2 + (-0.424 \cdot S_{6680}) + 0.03089 \cdot S_{6680}^2 \right) + \left(\left(\frac{S_{6680} - S_{6679}}{t_{6680} - t_{6679}} \right) \cdot 304.59 \right) \right) \right) \end{array} \right)}{6680}$$

$\bar{P}$ = 4931 ft·bf/s = 8.97 hp

(2) Calculate the reference value for power demand at the wheels, P_{ref}, based on the target vehicle speed using Equation 1066.330–1, substituting target values for actual values.

(3) Calculate the driving power error, P_{error}, by comparing the mean power demand calculated in paragraph (c)(1) of this section, $\bar{P}$, with the reference power calculated in paragraph (c)(2) of this section, P_{ref}, using the following equation:

$$P_{error} = \frac{\overline{P} - P_{ref}}{P_{ref}} \cdot 100\ \% \qquad \text{Eq. 1066.330-2}$$

Example:

$\bar{P}$= 8.965 hp

P_{ref} = 9.015 hp

$$P_{error} = \frac{8.965 - 9.015}{9.015} \cdot 100\ \%$$

P_{error} = -0.55%

(4) The driver power error may not exceed ±1.50% for a valid test.

Subpart E—Hybrids

§ 1066.401 Overview.

To determine State of Charge, Net Energy Change, and State of Charge correction for emission results, follow SAE J1711 and SAE J2711 (incorporated by reference in § 1066.710).

Subpart F—[Reserved]

Subpart G—Calculations

§ 1066.601 Overview.

(a) This subpart describes how to—

(1) Use the signals recorded before, during, and after an emission test to calculate distance-specific emissions of each regulated pollutant.

(2) Perform calculations for calibrations and performance checks.

(3) Determine statistical values.

(b) You may use data from multiple systems to calculate test results for a single emission test, consistent with good engineering judgment. You may also make multiple measurements from a single batch sample, such as multiple weighing of a PM filter or multiple readings from a bag sample. You may not use test results from multiple emission tests to report emissions. We allow weighted means where appropriate. You may discard statistical outliers, but you must report all results.

§ 1066.610 Mass-based and molar-based exhaust emission calculations.

(a) *General.* Calculate your total mass of emissions over a test cycle as specified in 40 CFR 86.144–94 or 40 CFR part 1065, subpart G.

(b) *Composite emissions over multiple test cycles.* For composite emission calculations over multiple test phases and corresponding weighting factors, *see* the standard-setting part.

Subpart H—Definitions and Other Reference Material

§ 1066.701 Definitions.

The definitions in this section apply to this part. The definitions apply to all subparts unless we note otherwise. Other terms have the meaning given in 40 CFR part 1065. The definitions follow:

Base inertia means a value expressed in mass units to represent the rotational inertia of the rotating dynamometer components between the vehicle driving tires and the dynamometer torque-measuring device, as specified in § 1066.150.

Driving schedule means a series of vehicle speeds that a vehicle must follow during a test. Driving schedules are specified in the standard-setting part. A driving schedule may consist of multiple test phases.

Duty cycle means a set of weighting factors and the corresponding test cycles, where the weighting factors are used to combine the results of multiple test phases into a composite result.

Road load coefficients means sets of A, B, and C road load force coefficients that are used in the dynamometer road load simulation, where road load force at speed S equals $A + B \cdot S + C \cdot S^2$.

Test phase means a duration over which a vehicle's emission rates are determined for comparison to an emission standard. For example, the standard-setting part may specify a complete duty cycle as a cold-start test phase and a hot-start test phase. In cases where multiple test phases occur over a duty cycle, the standard-setting part may specify additional calculations that weight and combine results to arrive at composite values for comparison against the applicable standards.

Unloaded coastdown means a dynamometer coastdown run with the vehicle wheels off the roll surface.

§ 1066.705 Symbols, abbreviations, acronyms, and units of measure.

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, 1995 Edition, "Guide for the Use of the International System of Units (SI)," which we incorporate by reference in § 1066.710. See 40 CFR 1065.25 for specific provisions related to these conventions. This section summarizes the way we use symbols, units of measure, and other abbreviations.

Symbols for quantities. This part uses the following symbols and units of measure for various quantities:

BILLING CODE 6560–60–P

Symbol	Quantity	Unit	Unit Symbol	Base SI units
Δ	symbol prefix to denote an interval	miles per hour	mph	
%	Percent	0.01	%	10^{-2}
d	Diameter	Inches	in	
F	Force	Pound force	lbf	
f	Frequency	Hertz	Hz	s^{-1}
I	Inertia	Pound mass	lbm	
i	indexing variable			
M	Mass	Pound mass	lbm	
N	total number in series			
n	total number of pulses in a series			
R	dynamometer roll revolutions	revolutions per minute	rpm	
RL	road load coefficient	horsepower	hp	
S	Speed	miles per hour	mph	
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
y	generic variable			

(b) *Symbols for chemical species.* This part uses the following symbols for chemical species and exhaust constituents:

Symbol	Species
CH_4	Methane
CO	carbon monoxide
CO_2	carbon dioxide
NMHC	nonmethane hydrocarbon
NMHCE	nonmethane hydrocarbon equivalent
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
N_2O	nitrous oxide
O_2	molecular oxygen
PM	particulate mass
THC	total hydrocarbon
THCE	total hydrocarbon equivalent

(c) *Superscripts.* This part uses the following superscripts to define a quantity:

Superscript	Quantity
overbar (such as $\bar{y}$)	arithmetic mean

(d) *Subscripts.* This part uses the following subscripts to define a quantity:

Subscript	Quantity
Int	speed interval
Abs	absolute quantity
Act	actual or measured condition
Actint	actual or measured condition over the speed interval
Atmos	atmospheric
B	base
C	coastdown
E	effective
Error	error
Exp	expected quantity
I	an individual of a series
Final	final
Init	initial quantity, typically before an emission test
Max	the maximum (i.e., peak) value expected at the standard over a test interval; not the maximum of an instrument range
Meas	measured quantity
Ref	reference quantity
Rev	revolution
Roll	dynamometer roll
Sat	saturated condition
Si	speed interval
Span	span quantity
Test	test quantity
uncork	uncorrected quantity
Zero	zero quantity

(e) *Other acronyms and abbreviations.* This part uses the following additional abbreviations and acronyms:

CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
FID	flame-ionization detector
NIST	National Institute for Standards and Technology
SAE	Society of Automotive Engineers
U.S.C.	United States Code

§ 1066.710 Reference materials.

Documents listed in this section have been incorporated by reference into this part. The Director of the Federal Register approved the incorporation by reference as prescribed in 5 U.S.C. 552(a) and 1 CFR part 51. Anyone may inspect copies at the U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave., NW., Room B102, EPA West Building, Washington, DC 20460 or 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.*

(a) *NIST material.* Table 1 of this section lists material from the National Institute of Standards and Technology that we have incorporated by reference. The first column lists the number and name of the material. The second column lists the section of this part where we reference it. Anyone may purchase copies of these materials from the Government Printing Office, Washington, DC 20402 or download them free from the Internet at *http://www.nist.gov.* Table 1 follows:

Table 1 of § 1066.710–NIST materials

Document number and name	Part 1066 reference
NIST Special Publication 811, 1995 Edition, Guide for the Use of the International System of Units (SI), Barry N. Taylor, Physics Laboratory	1066.20, 1066.705

(b) *SAE material.* Table 2 of this section lists material from the Society of Automotive Engineering that we have incorporated by reference. The first column lists the number and name of the material. The second column lists the sections of this part where we reference it. Anyone may purchase copies of these materials from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096 or *http://www.sae.org.* Table 2 follows:

Table 2 of § 1066.710–SAE materials

Document number and name	Part 1066 reference
SAE J1711:2010, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles	1066.401
SAE J2263:2008, Road Load Measurement Using On-Board Anemometry And Coastdown Techniques	1066.201, 1066.210, 1066.304
SAE J2264:1995, Chassis Dynamometer Simulation Of Road Load Using Coastdown Techniques	1066.304
SAE J2711: 2002, Recommended Practice for Measuring Fuel Economy and Emissions of Hybrid-Electric and Conventional Heavy-Duty Vehicles	1066.401

PART 1068—GENERAL COMPLIANCE PROVISIONS FOR HIGHWAY, STATIONARY, AND NONROAD PROGRAMS

15. The authority citation for part 1068 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

16. The heading of part 1068 is revised to read as set forth above.

Subpart A—[Amended]

17. 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 following engines and to equipment using the following engines (including owners, operators, parts manufacturers, and persons performing maintenance):

(1) Locomotives we regulate under 40 CFR part 1033.

(2) Heavy-duty motor vehicles and motor vehicle engines as specified in 40 CFR parts 1036 and 1037.

(3) Land-based nonroad compression-ignition engines we regulate under 40 CFR part 1039.

(4) Stationary compression-ignition engines certified using the provisions of 40 CFR part 1039, as indicated in 40 CFR part 60, subpart IIII.

(5) Marine compression-ignition engines we regulate under 40 CFR part 1042.

(6) Marine spark-ignition engines we regulate under 40 CFR part 1045.

(7) Large nonroad spark-ignition engines we regulate under 40 CFR part 1048.

(8) Stationary spark-ignition engines certified using the provisions of 40 CFR parts 1048 or 1054, as indicated in 40 CFR part 60, subpart JJJJ.

(9) Recreational engines and vehicles we regulate under 40 CFR part 1051 (such as snowmobiles and off-highway motorcycles).

(10) Small nonroad spark-ignition engines we regulate under 40 CFR part 1054.

(b) This part does not apply to any of the following engine or vehicle categories, except as specified in paragraph (d) of this section or as specified in other parts:

(1) Light-duty motor vehicles (*see* 40 CFR part 86).

(2) Highway motorcycles (*see* 40 CFR part 86).

(3) Aircraft engines (*see* 40 CFR part 87).

(4) Land-based nonroad compression-ignition engines we regulate under 40 CFR part 89.

(5) Small nonroad spark-ignition engines we regulate under 40 CFR part 90.

(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 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.

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. 32901 and 32902 and delegation of authority at 49 CFR 1.50, NHTSA proposes to amend 49 CFR chapter V as follows:

PART 523—VEHICLE CLASSIFICATION

18. The authority citation for part 523 continues to read as follows:

Authority: 49 U.S.C. 32901; delegation of authority at 49 CFR 1.50.

19. Revise § 523.2 to read as follows:

§ 523.2 Definitions.

As used in this part:

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 means the tire specified as standard equipment by a manufacturer on each vehicle configuration of a model type.

Basic vehicle frontal area is used as defined in 40 CFR 86.1803–01.

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, cut-away vans are considered cab-complete vehicles. A cab includes a steering column and passenger compartment. Note 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, in the case of automobiles to which either of those terms apply. With respect to automobiles to which neither of those 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).

Completed vehicle means a vehicle that requires no further manufacturing operations to perform its intended function.

Curb weight is defined the same as vehicle curb weight in 40 CFR 86.1803–01.

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.

Final stage manufacturer has the meaning given in 49 CFR 567.3.

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.

Gross combination weight rating or GCWR means the value specified by the manufacturer as the maximum allowable loaded weight of a combination vehicle (e.g. tractor plus trailer).

Gross vehicle weight rating or GVWR means the value specified by the vehicle manufacturer as the maximum design loaded weight of a single vehicle (e.g. vocational truck).

Heavy-duty truck means a non-passenger automobile meeting the criteria in § 523.6.

Heavy-duty off-road truck means a heavy-duty truck intended to be used extensively in off-road environments such as forests, oil fields, and construction sites. A vehicle may qualify as a heavy-duty off-road truck by meeting the criteria for "Off-road heavy-duty vocational trucks" or "Off-road truck tractors" or by getting separate approval, as follows:

(1) Off-road heavy-duty vocational trucks are those meeting the following criteria:

(i) The tires installed on the vehicle must be lug tires or contain a speed rating at or below 60 mph. For purposes of this section, a lug tire is one for which the elevated portion of the tread covers less than one-half of the tread surface.

(ii) The vehicle must include a vehicle speed limiter governed to 55 mph or less.

(2) Off-road truck tractors are those meeting the following criteria:

(i) The tires installed on the vehicle must be lug tires or contain a speed rating at or below 60 mph. For purposes of this section, a lug tire is one for which the elevated portion of the tread covers less than one-half of the tread surface.

(ii) The vehicle must include a vehicle speed limiter governed to 55 mph or less.

(iii) The vehicle must either:

(A) Contain power take-off (PTO) controls; or

(B) Have GVWR greater than 57,000 pounds and have axle configurations other than 4x2, 6x2, or 6x4 (axle configurations are expressed as total number of wheel hubs by number of drive wheel hubs).

(iv) The frame of the vehicle must have a resisting bending moment (RBM) greater than 2,000,000 inch-pounds. Use sound engineering judgment to determine the RBM for the frame.

(3) Vehicles not meeting the provisions in paragraphs (a) and (b) of this definition may still be considered as heavy-duty off-road trucks upon approval from the Administrators of NHTSA and EPA.

Incomplete vehicle means an assemblage consisting, at a minimum, of chassis (including the frame) structure, power train, steering system, suspension system, and braking system, in the state that those systems are to be part of the completed vehicle, but requires further manufacturing operations to become a completed vehicle.

Light truck means a non-passenger automobile meeting the criteria in § 523.5.

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 truck"' 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.

Motor home has the meaning given in 49 CFR 571.3.

Passenger-carrying volume means the sum of the front seat volume and, if any, rear seat volume, as defined in 40 CFR 600.315, 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 J1100a, Motor Vehicle Dimensions (Report of Human Factors Engineering Committee, Society of Automotive Engineers, approved September 1973 and last revised September 1975).

(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.

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.

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.

Van means a vehicle that has an integral enclosure fully enclosing the driver compartment and load carrying compartment. The distance from the leading edge of the foremost body section of vans is typically shorter than that of pickup trucks and sport utility vehicles.

Vocational vehicle means a vehicle that is constructed for a particular industry, trade or occupation such as construction, heavy hauling, mining, logging, oil fields and refuse.

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 86.1803–01 effective as of December 20, 2007.

20. Add a new § 523.6 to read as follows:

§ 523.6 Heavy-duty truck.

(a) A heavy-duty truck is any Class 2b through 8 non-passenger vehicle that is a commercial medium and 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 part, heavy-duty trucks are divided into three regulatory categories as follows:

(1) Heavy-duty pickup trucks and vans;

(2) Heavy-duty vocational trucks; and

(3) Truck tractors with a GVWR above 26,000 pounds.

(b) The heavy-duty truck classification does not include:

(1) Vehicles defined as medium duty passenger vehicles in 40 CFR 86.1803–01 on December 20, 2007.

(2) Recreational vehicles including motor homes.

(3) Vehicles excluded from the definition of "heavy-duty truck" because of vehicle weight or weight rating (such as light duty vehicles and light duty trucks as defined in § 523.5).

(4) Heavy-duty off-road vehicles.

21. Add a new § 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 and include cab-complete vehicles that are first sold as incomplete vehicles that substantially include the vehicle cab section.

22. Add a new § 523.8 to read as follows:

§ 523.8 Heavy-duty vocational trucks.

Heavy-duty vocational trucks are vocational vehicles with a gross vehicle weight rating (GVWR) above 8,500 pounds excluding:

(a) Heavy-duty pickup trucks and vans defined in § 523.7;

(b) Medium duty passenger vehicles;

(c) Truck tractors with a GVWR above 26,000 pounds; and

(d) Heavy-duty vocational trucks with sleeper cabs.

23. Add a new § 523.9 to read as follows:

§ 523.9 Truck tractors.

Truck tractors for the purpose of this part are considered as any truck tractor as defined in 49 CFR part 571 having a GVWR above 26,000 pounds and include any heavy-duty vocational truck with a sleeper cab.

PART 534—RIGHTS AND RESPONSIBILITIES OF MANUFACTURERS IN THE CONTEXT OF CHANGES IN CORPORATE RELATIONSHIPS

24. The authority citation for part 534 continues to read as follows:

Authority: 49 U.S.C. 32901; delegation of authority at 49 CFR 1.50.

25. Revise § 534.1 to read as follows:

§ 534.1 Scope.

This part defines the rights and responsibilities of manufacturers in the context of changes in corporate relationships for purposes of the fuel economy and fuel consumption programs established by 49 U.S.C. chapter 329.

26. Revise § 534.2 to read as follows:

§ 534.2 Applicability.

This part applies to manufacturers of passenger automobiles, light trucks, heavy-duty trucks and the engines manufactured for use in heavy-duty trucks as defined in 49 CFR part 523.

27. Revise § 534.4 to read as follows.

§ 534.4 Successors and predecessors.

For purposes of the fuel economy and fuel consumption programs, "manufacturer" includes "predecessors" and "successors" to the extent specified in paragraphs (a) through (d) of this section.

(a) Successors are responsible for any civil penalties that arise out of fuel economy and fuel consumption shortfalls incurred and not satisfied by predecessors.

(b) If one manufacturer has become the successor of another manufacturer during a model year, all of the vehicles or engines produced by those manufacturers during the model year are treated as though they were manufactured by the same manufacturer. A manufacturer is considered to have become the successor of another manufacturer during a model year if it is the successor on September 30 of the corresponding calendar year and was not the successor for the preceding model year.

(c)(1) For passenger automobiles and light trucks, fuel economy credits earned by a predecessor before or during model year 2007 may be used by a successor, subject to the availability of credits and the general three-year restriction on carrying credits forward and the general three-year restriction on carrying credits backward. Fuel economy credits earned by a predecessor after model year 2007 may be used by a successor, subject to the availability of credits and the general five-year restriction on carrying credits forward and the general three-year restriction on carrying credits backward.

(2) For heavy-duty trucks and heavy-duty truck engines, available fuel consumption credits earned by a predecessor after model year 2015, and in model years 2014 and 2015 if a manufacturer voluntarily complies in those model years, may be used by a successor, subject to the availability of credits and without restriction on carrying credits forward, except for the heavy-duty pickup truck and van category that have a 5 year carry forward expiry date, and the successor may use excess credits from the predecessor to offset a successor's past credit shortfall within the general three year restriction specified in the requirements of 49 CFR 535.7.

(d)(1) For passenger automobiles and light trucks, fuel economy credits earned by a successor before or during model year 2007 may be used to offset a predecessor's shortfall, subject to the availability of credits and the general three-year restriction on carrying credits forward and the general three-year restriction on carrying credits backward. Credits earned by a successor after model year 2007 may be used to offset a predecessor's shortfall, subject to the availability of credits and the general five-year restriction on carrying credits forward and the general three-year restriction on carrying credits backward.

(2) For heavy-duty trucks and heavy-duty truck engines, available credits earned by a successor after model year 2015, and in model years 2014 and 2015, if a manufacturer voluntarily complies in those model years, may be used by a predecessor within the guidelines of the three year provisions to offset a predecessor's past credit shortfall as specified in the requirements of 49 CFR 535.7.

28. Amend § 534.5 by revising paragraphs (a), (c), and (d) to read as follows:

§ 534.5 Manufacturers within control relationships.

(a) If a civil penalty arises out of a fuel economy or fuel consumption shortfall incurred by a group of manufacturers within a control relationship, each manufacturer within that group is jointly and severally liable for the civil penalty.

* * * * *

(c)(1) For passenger automobiles and light trucks, fuel economy credits of a manufacturer within a control relationship may be used by the group of manufacturers within the control relationship to offset shortfalls, subject to the agreement of the other manufacturers, the availability of the credits, and the general three year restriction on carrying credits forward or backward prior to or during model year 2007, or the general five year restriction on carrying credits forward and the general three-year restriction on carrying credits backward after model year 2007.

(2) For heavy-duty trucks and heavy-duty engines, credits of a manufacturer within a control relationship may be used by the group of manufacturers within the control relationship to offset shortfalls, subject to the agreement of the other manufacturers, the availability of the credits to carry forward without restriction, except for the heavy-duty pickup truck and van category that have a 5-year carry forward expiry date, and the general three year restriction on offsetting past credit shortfalls as specified in the requirements of 49 CFR 535.7.

(d)(1) For passenger automobiles and light trucks, if a manufacturer within a group of manufacturers is sold or otherwise spun off so that it is no longer within that control relationship, the manufacturer may use credits that were earned by the group of manufacturers within the control relationship while the manufacturer was within that relationship, subject to the agreement of the other manufacturers, the availability of the credits, and the general three-year restriction on carrying credits forward or backward prior to or during model year 2007, or the general five-year restriction on carrying credits forward and the general three-year restriction on carrying credits backward after model year 2007.

(2) For heavy-duty trucks and heavy-duty truck engines, if a manufacturer within a group of manufacturers is sold or otherwise spun off so that it is no longer within that control relationship, the manufacturer may use credits that were earned by the group of manufacturers within the control relationship while the manufacturer was within that relationship, subject to the agreement of the other manufacturers, the availability of the credits, and the requirements of 49 CFR 535.7.

* * * * *

29. Revise § 534.6 to read as follows.

§ 534.6 Reporting corporate transactions.

Manufacturers who have entered into written contracts transferring rights and responsibilities such that a different manufacturer owns the controlling stock or exerts control over the design, production or sale of automobiles or heavy-duty trucks to which Corporate Average Fuel Economy or Fuel Consumption standards apply shall report the contract to the agency as follows:

(a) The manufacturers must file a certified report with the agency affirmatively stating that the contract transfers rights and responsibilities between them such that one manufacturer has assumed a controlling stock ownership or control over the design, production or sale of vehicles. The report must also specify the first full model year to which the transaction will apply.

(b) Each report shall—

(1) Identify each manufacturer;

(2) State the full name, title, and address of the official responsible for preparing the report;

(3) Identify the production year being reported on;

(4) Be written in the English language; and

(5) Be submitted to: Administrator, National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE., Washington, DC 20590.

(c) The manufacturers may seek confidential treatment for information provided in the certified report in accordance with 49 CFR part 512.

30. A new part 535 is added to chapter V to read as follows:

PART 535—MEDIUM- AND HEAVY-DUTY VEHICLE FUEL EFFICIENCY PROGRAM

Sec.

Authority: 49 U.S.C. 32902; delegation of authority at 49 CFR 1.50.

§ 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 (hereafter referenced as heavy-duty trucks) and engines 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 these vehicles.

§ 535.2 Purpose.

The purpose of this part is to reduce the fuel consumption of new heavy-duty trucks 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 vehicle and chassis manufacturers of all new heavy-duty trucks, as defined in 49 CFR part 523, and to the manufacturers of all engines manufactured for use in the applicable vehicles (hereafter referenced as heavy-duty engines).

(b) Vehicle manufacturer, for the purpose of this part, means a manufacturer that manufactures heavy-duty pickup trucks and vans or truck tractors as complete vehicles.

(c) Chassis manufacturer, for the purpose of this part, means a manufacturer that manufactures the chassis of a vocational vehicle.

(d) The heavy-duty engines excluded from the requirements of this part include:

(1) Engines used in medium-duty passenger vehicles.

(2) Engines fueled by other than petroleum fuels, natural gas, liquefied petroleum gas, and methanol.

(e) Small business manufacturers as defined by the Small Business Administration at 13 CFR 121.201, and as reported to and approved by the Administrators of EPA and NHTSA, are exempted from the requirements of this part.

§ 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 Public Law 94–163 and 96–425.

Administrator means the Administrator of the National Highway Traffic Safety Administration (NHTSA) or the Administrator's delegate.

Averaging set means, for the purpose of this part, the collective regulatory category (or subcategory) of heavy-duty pickup trucks and vans and is made up of multiple test groups that determine the manufacturer's "fleet average fuel consumption" as defined in this section.

Cab-complete vehicle has the meaning given in 49 CFR part 523.

Chassis 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 vehicle has the meaning given in 49 CFR part 523.

Compression-ignition means relating to a type of reciprocating, internal-combustion engine, such as a diesel engine, that is not a spark-ignition engine.

Credits (or fuel consumption credits) in this part means an earned or purchased allowance recognizing the fuel consumption of a particular manufacturer's vehicles or engines within a particular regulatory subcategory or fleet exceeds (credit surplus or positive credits) or falls below (credit shortfall or negative credits) that manufacturer's fuel consumption standard for a regulatory subcategory or fleet for a given model year. The value of a credit is calculated according to § 535.7.

Curb weight has the meaning given in 40 CFR 86.1803–01.

Day cab means a type of truck tractor cab that is not a "sleeper cab", as defined in this section.

Dedicated truck has the same meaning as dedicated automobile as defined in 49 U.S.C. 32901(a)(8).

Dual fueled or flexible-fuel truck has the same meaning as dual fueled automobile as defined in 49 U.S.C. 32901(a)(9).

Engine family has the meaning given in 40 CFR 1036.230.

Family certification level (FCL) means the family certification limit for an engine family as defined in 40 CFR 1036.801.

Family emission limit (FEL) means the family emission limit for a vehicle family as defined in 40 CFR 1036.801.

Final-stage manufacturer has the meaning given in 49 CFR part 523.

Fleet in this part means all the heavy-duty trucks 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 efficiency means the amount of work performed for each gallon of fuel consumed.

Gross combination weight rating (GCWR) has the meaning given in 49 CFR part 523.

Gross vehicle weight rating (GVWR) has the meaning given in 49 CFR part 523.

Hearing Officer means a NHTSA employee who has been delegated the authority to assess civil penalties by the Administrator.

Heavy-duty truck has the meaning given in 49 CFR part 523.

Incomplete vehicle has the meaning given in 49 CFR 567.3.

Liquefied petroleum gas (LPG) has the meaning given in 40 CFR 1036.801.

Model type has the meaning given in 40 CFR 600.002.

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. A manufacturer must use the date on which a vehicle is shipped from the factory in which the assembly process is finished as the date of manufacture for determining model year. For example, where a certificate holder (*i.e.*, a manufacturer that obtains a vehicle emission certification from EPA) sells a cab-complete vehicle to a secondary vehicle manufacturer, the model year is based on the date the vehicle leaves the factory as a cab-complete vehicle.

Natural gas has the meaning given in 40 CFR 1036.801.

NHTSA Enforcement means the NHTSA Associate Administrator for Enforcement, or his or her designee.

Notice of violation means a notification of violation and preliminary assessment of penalty issued by the Chief Counsel to a party.

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.

Power take-off (PTO) control means a device used for hybrid applications in heavy-duty vocational trucks or truck tractors such as a secondary hybrid power source to operate secondary equipment like a utility bucket or dump bed that would otherwise require the use of the truck's engine.

Regulatory category means each of the three types of heavy-duty trucks defined in 49 CFR 523.6 and the heavy-duty engines defined in § 535.3.

Regulatory subcategory means the sub-groups in each regulatory category to which fuel consumption requirements apply, and are defined as follows:

(1) Heavy-duty pick-up trucks and vans

(2) Vocational light-heavy vehicles at or below 19,500 pounds GVWR.

(3) Vocational medium-heavy vehicles above 19,500 pounds GVWR but at or below 33,000 pounds GVWR.

(4) Vocational heavy-heavy vehicles above 33,000 pounds GVWR.

(5) Low roof day cab tractors above 26,000 pounds GVWR but at or below 33,000 pounds GVWR.

(6) Mid roof day cab tractors above 26,000 pounds GVWR but at or below 33,000 pounds GVWR.

(7) High roof day cab tractors above 26,000 pounds GVWR but at or below 33,000 pounds GVWR.

(8) Low roof day cab tractors above 33,000 pounds GVWR.

(9) Mid roof day cab tractors above 33,000 pounds GVWR.

(10) High roof day cab tractors above 33,000 pounds GVWR.

(11) Low roof sleeper cab tractors above 33,000 pounds GVWR.

(12) Mid roof sleeper cab tractors above 33,000 pounds GVWR.

(13) High roof sleeper cab tractors above 33,000 pounds GVWR.

(14) Light heavy-duty diesel engines in Class 2b to 5 trucks with a GVWR above 8,500 pounds but at or below 19,500 pounds.

(15) Medium heavy-duty diesel engines in Class 6 and 7 trucks with a GVWR above 19,500 but at or below 33,000 pounds.

(16) Heavy heavy-duty diesel engines in Class 8 trucks with a GVWR above 33,000 pounds.

(17) Spark ignition engines in Class 2b to 8 trucks with a GVWR above 8,500 pounds.

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. Once the maximum height is determined, roof heights are divided into the following categories:

(1) Low roof means relating to a vehicle with a roof height of 120 inches or less (includes tractors with adjustable fairings).

(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.

Sleeper cab means a type of truck tractor cab including 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.

Spark-ignition engines 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.

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 (a regulatory subcategory) and is used by NHTSA for determining the fleet average consumption.

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.

Useful life has the meaning given in 40 CFR 1037.801.

Vehicle configuration has the meaning given in 40 CFR 600.002.

Vehicle family has the meaning given in 40 CFR 1037.230.

Violation means a failure to comply with an applicable fuel consumption standard for a regulatory subcategory of vehicles or engines, after all flexibilities available under § 535.7 are taken into account.

§ 535.5 Standards.

(a) *Heavy-duty pickup trucks and vans.* Each manufacturer of heavy-duty pickup trucks and vans shall comply with the fuel consumption standards in this paragraph expressed in gallons per 100 miles.

(1) *For model years 2016 and later.* Each manufacturer must comply with the fleet average standard derived from the unique vehicle configuration (payload, towing capacity and drive configuration) target standards of the model types that make up the manufacturer's fleet in a given model year. Each vehicle configuration 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.

(2) *Vehicle configuration target standards.* (i) Two alternatives exist for determining the vehicle configuration target standards for model years 2016 and later. 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 vehicle configuration target standards as specified in this paragraph (a)(2)(ii), using the appropriate coefficients from Table 1 of this section to choose between the alternatives in paragraphs (a)(2)(i)(A) and (B) of this section. For electric or fuel cell heavy-duty trucks, use compression-ignition vehicle coefficients "c and d" and for hybrid (including plug-in hybrid), dedicated and dual-fueled trucks, use coefficients "c and d" appropriate for the engine type used. Round each standard to the nearest 0.1 gallons per 100 miles and specify all weights in pounds rounded to the nearest pound. Calculate the vehicle configuration target standards using the following equation:

Vehicle Configuration Target Standard (gallons per 100 miles) = [c × (WF)] + d

Where:

WF = Work Factor = [0.75 × (Payload Capacity + Xwd)] + [0.25 × 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 1– Equation Coefficients for Vehicle Configuration Target Standards

Alternative 1 – Fixed Target Standards		
Compression-ignition Vehicle Coefficients for Model Years 2016 and later		
Model Year	c	d
2016 and later	0.000432	3.33
Spark-ignition Vehicle Coefficients for Model Years 2016 and later		
2016 and later	0.000448	3.45
Alternative 2 – Phased-in Target Standards		
Compression-ignition Vehicle Coefficients for Model Years 2016 and later		
Model Year	c	d
2016	0.000452	3.48
2017	0.000437	3.37
2018 and later	0.000408	3.15
Spark-ignition Vehicle Coefficients for Model Years 2016 and later		
2016	0.000461	3.55
2017	0.000452	3.48
2018 and later	0.000432	3.33

(3) *Fleet average fuel consumption standard.* (i) Calculate each manufacturer's fleet average fuel consumption standard from the vehicle configuration 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 fleet (compression-ignition and spark-ignition vehicles) for a given model year, rounded to the nearest 0.1 gallons per 100 miles:

$$\text{Fleet Average Standard} = \frac{\sum\left[\text{Vehicle Configuration Target Standard}_i \times \text{Volume}_i\right]}{\sum\left[\text{Volume}_i\right]}$$

Where:

Vehicle Configuration Target Standard$_i$ = fuel consumption standard for each group of vehicles with same payload, towing capacity and drive configuration.

Volume$_i$ = production volume of each unique vehicle configuration of a model type based upon payload, towing capacity and drive configuration.

(ii) A manufacturer complies with the requirements of this part, if at the end of the model year, it provides reports, as specified in § 535.8, to the Administrator by the required deadlines and meets one of the following conditions:

(A) The manufacturer's fleet average performance, as determined in § 535.6, is less than the fleet average standard; or

(B) The manufacturer uses one or more of the credit flexibilities provided under NHTSA's Averaging, Banking and Trading Program, as specified in § 535.7, to comply with standards; and

(iii) Manufacturers must select an alternative for vehicle configuration target standards at the same time they submit the model year 2016 Pre-Certification Compliance 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.

(iv) A manufacturer failing to comply with the provisions specified in paragraph (a)(3)(ii) of this section is liable to pay civil penalties in accordance with § 535.9.

(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)(3)(iii) and (iv) in this section, for example, in order to begin accumulating credits through over-compliance with the applicable standard.

(ii) A manufacturer must declare its intent to voluntarily comply with fuel consumption standards at the same time it submits a Pre-Certification Compliance 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.

(iii) Calculate separate vehicle configuration target standards for compression-ignition and spark-ignition vehicles for model years 2013 through 2015 using the equation in paragraph (a)(2)(ii) in this section, substituting the appropriate values for the coefficients in Table 2 of this section as appropriate.

Table 2 – Voluntary Compliance Equation Coefficients for Vehicle Fuel Consumption Standards

Compression-ignition Vehicle Coefficients For Voluntary Compliance in Model Years 2013 through 2015		
Model Year	c	d
2013 and 14	0.000470	3.62
2015	0.000466	3.59
Spark-ignition Vehicle Coefficients for Voluntary Compliance in Model Years 2013 through 2015		
Model Year	c	d
2013 and 14	0.000473	3.65
2015	0.000471	3.63

(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) *Cab-complete vehicles.* The provisions of this section apply to applicable cab-complete vehicles in the same manner as they apply to complete vehicles. Calculate the unique vehicle configuration target standards based on the same values that would apply for the most similar complete vehicle to the cab-complete vehicle.

(6) *Low volume exclusion.* A manufacturer may exclude a limited number of vehicles from the standards of this section. The number of excluded vehicles may not exceed 2000 in any model year, unless the total production of vehicles in this category for that model year is greater than 100,000 and the excluded vehicles are not more than 2.00 percent of the manufacturer's total production of vehicles in this subcategory for any model year. For example, a vehicle manufacturer producing 200,000 vehicles in a given model year could exclude up to 4,000 vehicles under this paragraph (a)(6). The vehicle standards and requirements of paragraph (b) of this section apply for the excluded vehicles. The standards in paragraph (d) of this section also apply for engines used in these excluded vehicles. Manufacturers must submit information in their Pre-Certification Compliance Report, as specified in § 535.8, describing how they intend to use the provisions of this paragraph (a)(6). If the chassis manufacturer is not the engine manufacturer, the chassis manufacturer must notify the engine manufacturer, as required by EPA in 40 CFR 1037.104, that their engines are subject to the requirements of paragraph (d) of this section and are intended for use in excluded vehicles.

(b) *Heavy-duty vocational trucks.* Each manufacturer of heavy-duty vocational trucks shall comply with the fuel consumption standards in this paragraph (b) expressed in gallons per 1000 ton-miles.

(1) *For model years 2016 and later.* Each chassis manufacturer of heavy-duty vocational trucks must comply with the fuel consumption standards in paragraph (b)(3) of this section.

(i) The heavy-duty vocational truck chassis category is subdivided by GVWR into three regulatory subcategories, each with its own assigned standard.

(ii) For purposes of certifying vehicles to fuel consumption standards, manufacturers must divide their product lines into vehicle families that have similar emissions and fuel consumption features, as specified by EPA in 40 CFR part 1037, subpart C, and these families will be subject to the applicable standards. Each vehicle family is limited to a single model year.

(iii) Standards for heavy-duty vocational truck engines are given in paragraph (d) of this section.

(iv) A manufacturer complies with the requirements of this part, if at the end of the model year, it provides reports, as specified in § 535.8, to the Administrator by the required deadlines and meets one of the following conditions:

(A) The manufacturer's fuel consumption performance for each vehicle family, as determined in § 535.6, is lower than the applicable standard; or

(B) The manufacturer uses one or more of the credit flexibilities provided under NHTSA's Averaging, Banking and Trading Program, specified in § 535.7, to comply with standards; and

(v) A manufacturer failing to comply with the provisions specified in paragraph (b)(1)(iv) of this section is liable to pay civil penalties in accordance with § 535.9.

(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 each regulatory subcategory. For example, a manufacturer may choose to comply early in order to begin accumulating credits through over-compliance with the applicable standard.

(ii) A manufacturer must declare its intent to voluntarily comply with fuel consumption standards at the same time it submits a Pre-Certification Compliance 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.

(3) *Regulatory subcategory standards.* The fuel consumption standards for heavy-duty vocational trucks are given in the following table:

Table 3 – Heavy-Duty Vocational Truck Fuel Consumption Standards

Fuel Consumption Standards (gallons per 1000 ton-miles) Effective for Model Years 2017 and later			
Regulatory Subcategories	Light Heavy Vehicles Class 2b - 5	Medium Heavy Vehicles Class 6 - 7	Heavy Heavy Vehicles Class 8
Fuel Consumption Standard	33.8	20.0	10.5
Fuel Consumption Voluntary Standards (gallons per 1000 ton-miles) Effective for Model Years 2013 to 2016			
Regulatory Subcategories	Light Heavy Vehicles Class 2b - 5	Medium Heavy Vehicles Class 6 - 7	Heavy Heavy Vehicles Class 8
Fuel Consumption Standard	35.2	20.8	10.7

(c) *Truck tractors.* Each manufacturer of truck 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.

(1) *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) The truck tractor category is subdivided by roof height and cab design into nine regulatory subcategories as shown in Table 4 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 into vehicles families that have similar emissions and fuel consumption features, as specified by EPA in 40 CFR part 1037, subpart C, 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.

(iv) A manufacturer complies with the requirements of this part, if at the end of the model year, it provides reports, as specified in § 535.8, to the Administrator by the required deadlines and meets one of the following conditions:

(A) The manufacturer's fuel consumption performance for each vehicle family, as determined in § 535.6, is lower than the applicable standard; or

(B) The manufacturer uses one or more of the credit flexibilities provided under NHTSA's Averaging, Banking and Trading Program, specified in § 535.7, to comply with standards; and

(v) A manufacturer failing to comply with the provisions specified in paragraph (c)(1)(iv) of this section is liable to pay civil penalties in accordance with § 535.9.

(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 each regulatory subcategory. For example, a manufacturer may choose to comply early in order to begin accumulating credits through over-compliance with the applicable standard.

(ii) A manufacturer must declare its intent to voluntarily comply with fuel consumption standards at the same time it submits a Pre-Certification Compliance 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.

(3) *Regulatory subcategory standards.* The fuel consumption standards for truck tractors are given in the following table:

Table 4 – Truck Tractor Fuel Consumption Standards

Fuel Consumption Standards (gallons per 1000 ton-miles) Effective for Model Years 2017 and later			
Regulatory Subcategories	Day Cab		Sleeper Cab
	Class 7	Class 8	Class 8
Low Roof	10.1	7.7	6.3
Mid Roof	10.1	7.7	6.8
High Roof	11.4	8.5	7.0
Fuel Consumption Standards (gallons per 1000 ton-miles) Effective for Model Years 2013 to 2016			
Regulatory Subcategories	Day Cab		Sleeper Cab
	Class 7	Class 8	Class 8
Low Roof	10.3	7.8	6.3
Mid Roof	10.3	7.8	6.9
High Roof	11.6	8.6	7.1

(d) *Heavy-duty engines.* Each manufacturer of heavy-duty engines shall comply with the fuel consumption standards in this paragraph (d) expressed in gallons per 100 brake-horsepower-hours;

(1) *For model years 2017 and later compression-ignition engines and for model years 2016 and later spark-ignition engines.* Each manufacturer must comply with the fuel consumption standard in paragraph (d)(3) of this section.

(i) The heavy-duty engine regulatory category is divided into four regulatory subcategories, three compression-ignition subcategories and one spark-ignition subcategory, as shown in Table 5 of this section.

(ii) Separate standards exist for engines manufactured for use in heavy-duty vocational trucks and in truck tractors.

(iii) For purposes of certifying engines to fuel consumption standards, manufacturers must divide their product lines into engine families that have similar fuel consumption features, as specified by EPA in 40 CFR part 1036, subpart C, and these families will be subject to the same standards. Each engine family is limited to a single model year.

(iv) A manufacturer complies with the requirements of this part, if at the end of the model year, it provides reports, as specified in § 535.8, to the Administrator by the required deadlines and meets one of the following conditions:

(A) The manufacturer's fuel consumption performance of each engine family as determined in § 535.6 is less than the applicable standard; or

(B) The manufacturer uses one or more of the flexibilities provided under NHTSA's Averaging, Banking and Trading Program, specified in § 535.7, to comply with standards; and

(v) A manufacturer failing to comply with the provisions specified in paragraph (d)(1)(iv) of this section is liable to pay civil penalties in accordance with § 535.9.

(2) *Voluntary compliance.* (i) For model years 2013 through 2016 for compression-ignition engines, and for model years 2013 through 2015 for spark-ignition engines, a manufacturer may choose voluntarily to comply with the fuel consumption standards provided in paragraph (d)(3) of this section. For example, a manufacturer may choose to comply early in order to begin accumulating credits through over-compliance with an applicable standard.

(ii) A manufacturer must declare its intent to voluntarily comply with fuel consumption standards at the same time it submits a Pre-Certification Compliance 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.

(3) *Regulatory subcategory standards.* The fuel consumption standards for heavy-duty engines are given in the following table:

Table 5 – Heavy-Duty Engine Standards

Fuel Consumption Standards (gallons per100 bhp-hr)						
Regulatory Subcategory	Light Heavy-Duty Compression-Ignition Engine	Medium Heavy-Duty Compression-Ignition Engine		Heavy Heavy-Duty Compression-Ignition Engine		Spark-ignition Engines
Truck Application	Vocational	Vocational	Tractor	Vocational	Tractor	All
Effective Model Years	2017 and later					2016 and later
Fuel Consumption Standard	5.57	5.57	4.78	5.45	4.52	7.05
Fuel Consumption Standards for Voluntary Compliance (gallons per100 bhp-hr)						
Regulatory Subcategory	Light Heavy-Duty Diesel Engine	Medium Heavy-Duty Diesel Engine		Heavy Heavy-Duty Diesel Engine		Spark-ignition Engine
Truck Application	Vocational	Vocational	Tractor	Vocational	Tractor	All
Effective Model Years	2013 through 2016					2013 through 2015
Voluntary Fuel Consumption Standard	5.89	5.89	4.93	5.57	4.67	7.05

§ 535.6 Measurement and calculation procedures.

(a) Manufacturers must calculate the fleet average fuel consumption of heavy-duty pickup trucks and vans that are manufactured in a model year and compare the value to the fleet average fuel consumption standard, determined in § 535.5, as follows:

(1) Manufacturers must calculate the fleet average fuel consumption from the average fuel economy of the production weighted test results for the test groups that make up the manufacturer's fleet of heavy-duty pickup trucks and vans as specified in 40 CFR part 86, subpart S, and 40 CFR part 600.

(i) Test groups are selected according to EPA in 40 CFR part 86, subpart S.

(ii) Determine the fuel economy applicable for each test group, in miles per gallon, according to EPA in 40 CFR part 600.

(A) Test conventional gasoline and diesel fueled vehicle test groups and, determine the fuel economy values in accordance with 40 CFR part 600.

(B) Test dual fueled (flexible fueled) vehicle test groups and determine the fuel economy values in accordance with 40 CFR part 600.

(C) Test dedicated (alternative) fueled vehicle test groups and determine the fuel economy values in accordance with 40 CFR part 600.

(D) Test advanced technology vehicles including electric vehicles, fuel cell vehicles, hybrid vehicles and plug-in hybrid electric vehicles and determine the fuel economy values in accordance with 40 CFR part 600.

(E) Test cab-chassis complete vehicle test groups and determine the average fuel economy values in accordance with 40 CFR part 600. Each manufacturer must determine the fuel economy values using the same test weight and other dynamometer settings as apply to that of complete vehicle from which was used for the WF value in § 535.5(a). For certification, a manufacturer may submit the test data from that similar vehicle instead of performing the test on the cab-complete vehicle.

(F) Manufacturers must calculate their fleet average fuel economy value, in miles per gallon, from the fuel economy values of the test groups in accordance with 40 CFR part 600.

(G) Manufacturers must calculate an equivalent fleet average fuel consumption value, in gallons per 100 miles, from the average fuel economy value of the fleet, in miles per gallon, using the following equation:

Fleet Average Fuel Consumption Value (gallons per 100 miles) = 1/[Average Fuel Economy Value of the Fleet (miles per gallon) × (10^2)]

(2) The manufacturer must submit equivalent fuel consumption values for each test group and its fleet to NHTSA and EPA in accordance with § 535.8. After each model year ends, EPA will verify the manufacturer's fuel economy levels for each test group and the fleet using testing and verify the equivalency of fuel consumption values. EPA will prepare a final report with all the verified values and submit the report to the NHTSA within three months of receiving the manufacturer's end-of-the-year and final year reports as specified in § 535.8.

(3) NHTSA will use the verified values provided by EPA in determining

compliance with fuel consumption standards in § 535.5 and for verifying end of year fuel consumption credits under its ABT program specified in § 535.7.

(b) The manufacturer must calculate the fuel consumption value for each vehicle family that makes up its fleet of heavy-duty vocational trucks in each regulatory subcategory and compare the results to the applicable fuel consumption standard, determined in § 535.5, as follows:

(1) Manufacturers must determine the family emission limit (FEL) for each vocational truck vehicle family in accordance with 40 CFR part 1037, subpart F.

(i) Determine the vehicle families in accordance with 40 CFR 1037.230.

(ii) Use the attribute values in the GEM Model to determine the fuel consumption values, in gallons per 1,000 ton-miles, for each vehicle type within the test groups and the FEL for each vehicle family as specified in 40 CFR 1037.241 and 40 CFR part 1037, subpart F.

(iii) Round each fuel consumption value to the nearest 0.1 gallons per 1,000 ton-miles.

(2) The manufacturer must submit the vehicle type fuel consumption values and the FELs for vehicle families to NHTSA and EPA in accordance with § 535.8. After each model year ends, EPA will verify the manufacturer's CO_2 family emission limit through modeling and verify the equivalent fuel consumption values.

(c) Manufacturers must calculate the fuel consumption value for each vehicle family that makes up the manufacturer's fleet of truck tractors in each regulatory subcategory and compare the results to the applicable fuel consumption standard, determined in § 535.5, as follows:

(1) Manufacturers must determine the family emission limit (FEL) for the truck tractor vehicle family in accordance with 40 CFR part 1037, subpart F.

(i) Determine the vehicle families in accordance with 40 CFR 1037.230.

(ii) Use the attribute values in the GEM Model to determine the fuel consumption values, in gallons per 1,000 ton-mile, for each vehicle type within the test groups and the FEL for each vehicle family as specified in 40 CFR 1037.241 and 40 CFR part 1037, subpart F.

(iii) Round each fuel consumption value to the nearest 0.1 gallons per 1,000 ton-miles.

(2) The manufacturer must submit the vehicle type fuel consumption values and the FELs for vehicle families to NHTSA and EPA in accordance with § 535.8. After each model year ends, EPA will verify the manufacturer's CO_2 family emission limit through modeling and verify the equivalent fuel consumption values.

(d) The manufacturer must calculate the fuel consumption value for each engine family for engines installed in vehicles that make up the manufacturer's fleet of heavy-duty trucks in each regulatory subcategory and compare the results to the applicable fuel consumption standard, determined in § 535.5, as follows:

(1) The manufacturer must determine the CO_2 emission values for the family certification level (FCL) of each engine family within the heavy-duty engine regulatory subcategories for each model year, in accordance with 40 CFR part 1036, subpart C, and then calculate equivalent fuel consumption values for each family certification level.

(i) Determine the CO_2 family certification level in grams per bhp-hr.

(ii) Calculate equivalent fuel consumption values, in gallons per 100 bhp-hr.

(iii) Round each fuel consumption value to the nearest 0.1 gallon per 100 bhp-hr.

(2) 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. 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.

(3) 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):

(i) Engines certified as hybrid engines or power packs.

(ii) Engines certified as hybrid engines designed with PTO capability and that are sold with the engine coupled to a transmission.

(iii) Engines certified as Rankine-cycle engines.

(4) Manufacturers must submit the engine type fuel consumption values and the FCLs for engine families to NHTSA and EPA in accordance with § 535.8. After each model year ends, EPA will verify the manufacturer's CO_2 family certification levels through modeling and verify the equivalent fuel consumption values.

§ 535.7 Averaging, banking, and trading (ABT) Program.

(a) *Fuel consumption credits (FCC).* At the end of each model year, manufacturers may earn credits for exceeding the fuel consumption standards specified in this regulation. Manufacturers may average, bank, and trade fuel consumption credits for purposes of complying with the standards as described in this section.

(b) *ABT provisions for heavy-duty pickup trucks and vans.* (1) This regulatory category consists of one regulatory subcategory, heavy-duty pickup trucks and vans.

(2) Manufacturers that manufacture vehicles within this regulatory subcategory shall calculate credits at the end of each model year based upon the final average fleet fuel consumption standard and final average fleet fuel consumption performance value within this one regulatory subcategory as identified in paragraph (a)(8) of this section.

(3) Fuel consumption levels below the standard create a "credit surplus," while fuel consumption levels above the standard create a "credit shortfall."

(4) Surplus credits generated and calculated within this regulatory subcategory may only be used to offset a credit shortfall in this same regulatory subcategory.

(5) Surplus credits may be traded among credit holders but must stay within the same regulatory subcategory.

(6) Surplus credits, if not used to offset a credit shortfall 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 earned. For example, credits earned in model year 2014 may be utilized through model year 2019.

(7) 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.

(8) Calculate the value of credits generated in a model year for this regulatory subcategory using the following equation:

$$\text{Total MY Fleet FCC (gallons)} = (\text{Std} - \text{Act}) \times (\text{Volume}) \times (\text{UL}) \times (10^2)$$

Where:

Std = Fleet average fuel consumption standard (gal/100 mile).

Act = Fleet average actual fuel consumption value (gal/100 mile).

Volume = the total production of vehicles in the regulatory subcategory.
UL = the useful life for the regulatory subcategory (120,000 miles).

(9) In model year 2013, if a manufacturer voluntarily complies, it may calculate credits for its entire fleet, as specified in paragraph (b)(8) of this section, or it may choose to calculate only advanced technology credits for its electric and zero emissions vehicles as specified in paragraph (e)(1) of this section.

(c) *ABT provisions for vocational trucks and tractors.* (1) The two regulatory categories for vocational trucks and tractors consist of 12 regulatory subcategory as follows:

(i) Vocational trucks with a GVWR up to and including 19,500 pounds (Light Heavy-Duty (LHD));

(ii) Vocational trucks with a GVWR above 19,500 pounds and no greater than 33,000 pounds (Medium Heavy-Duty (MHD));

(iii) Vocational trucks with a GVWR over 33,000 pounds (Heavy Heavy-Duty (HHD));

(iv) Low roof day cab tractors with a GVWR above 26,000 pounds and no greater than 33,000 pounds;

(v) Mid roof day cab tractors with a GVWR above 26,000 pounds and no greater than 33,000 pounds;

(vi) High roof day cab tractors with a GVWR above 26,000 pounds and no greater than 33,000 pounds;

(vii) Low roof day cab tractors with a GVWR above 33,000 pounds;

(viii) Mid roof day cab tractors with a GVWR above 33,000 pounds;

(ix) High roof day cab tractors with a GVWR above 33,000 pounds;

(x) Low roof sleeper cab tractors with a GVWR above 33,000 pounds;

(xi) Mid roof sleeper cab tractors with a GVWR above 33,000 pounds; and

(xii) High roof sleeper cab tractors with a GVWR above 33,000 pounds.

(2) Manufacturers that manufacture vehicles within either of these two vehicle categories, in one or more of the regulatory subcategories, shall calculate a total credit balance within each regulatory subcategory at the end of each model year based upon final production volumes and the sum of the credit balances derived for each of the vehicle family groups within each regulatory subcategory as defined by EPA.

(3) Each designated vehicle family group has a "family emissions limit" (FEL) which is compared to the associated regulatory subcategory standard. A FEL that falls below the regulatory subcategory standard creates "positive credits," while fuel consumption level of a family group above the standard creates "negative credits."

(4) Manufacturers shall sum all shortfalls and surplus credits for each vehicle family within a regulatory subcategory 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.

(5) A surplus total credit balance generated and calculated within a regulatory subcategory may only be used to offset credit shortfalls in this same regulatory subcategory.

(6) Surplus credits may be traded among credit holders but must stay within the same regulatory subcategory.

(7) Surplus credits, if not used to offset past or current model year credit shortfalls may be banked by the manufacturer for use in future model years, or traded.

(8) Credit shortfalls must be offset by available surplus credits within three model years after a shortfall has incurred. If the shortfall cannot be offset, the manufacturer is liable for civil penalties as discussed in § 535.9.

(9) The value of credits generated in a model year is calculated as follows:

(i) Calculate the value of credits generated in a model year for each vehicle family within a regulatory subcategory using the following equation:

$$\text{Vehicle Family FCC (gallons)} = (\text{Std} - \text{FEL}) \times (\text{Payload}) \times (\text{Volume}) \times (\text{UL}) \times (10^3)$$

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 = the prescribed payload in tons for each regulatory subcategory as shown in the following table:

Regulatory subcategory	Payload (Tons)
LHD Vocational Trucks	2.85
MHD Vocational Trucks	5.60
HHD Vocational Trucks	19.00
Class 7 Tractor	12.50
Class 8 Tractor	19.00

Volume = the number 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 Trucks	110,000
MHD Vocational Trucks	185,000
HHD Vocational Trucks	435,000
Class 7 Tractor	185,000
Class 8 Tractor	435,000

(ii) Calculate the total credits generated in a model year for each regulatory subcategory equals using the following equation:

Total regulatory subcategory MY credits = Σ Vehicle family credits within each regulatory subcategory

(d) *ABT provisions for heavy-duty engines.* (1) Heavy-duty engines consist of four regulatory subcategories as follows:

(i) Spark-ignition engines.

(ii) Light heavy-duty compression-ignition engines.

(iii) Medium heavy-duty compression-ignition engines.

(iv) Heavy heavy-duty compression-ignition engines.

(2) Manufacturers that manufacture engines within one or more of the regulatory subcategories, shall calculate a total credit balance within each regulatory subcategory at the end of each model year based upon final production volumes and the sum of the credit balances derived for each of the engine families within each regulatory subcategory as defined by EPA.

(3) 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 "negative credits."

(4) Manufacturers shall sum all surplus and shortfall credits for each engine family within a regulatory subcategory to obtain the total credit balance for the model year before rounding. Round the sum of fuel consumptions credits to the nearest gallon.

(5) A surplus total credit balance generated and calculated within a regulatory subcategory may only be used to offset credit shortfalls in this same regulatory subcategory.

(6) Surplus credits may be traded among credit holders but must stay within the same regulatory subcategory.

(7) Surplus credits, if not used to offset past or current model year credit shortfalls may be banked by the manufacturer for use in future model years, or traded.

(8) Credit shortfalls must be offset by available surplus credits within three model years after shortfall was incurred. If the shortfall cannot be offset, the manufacturer is liable for civil penalties as discussed in § 535.9.

(9) The value of credits generated in a model year is calculated as follows:

(i) The value of credits generated in a model year for each engine family within a regulatory subcategory equals

Engine Family FCC (gallons) = (Std − FCL) × (CF) × (Volume) × (UL) × (10^2)

Where:

Std = the standard for the respective engine regulatory subcategory (gal/100 bhp-hr).

FCL = family certification level for the engine family (gal/100 bhp-hr).

CF = a transient cycle conversion factor in bhp-hr/mile which is the integrated total cycle brake 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 Trucks, Spark Ignited (SI), and Light Heavy-Duty Diesel Engines	110,000
Class 6-7 Vocational Trucks and Medium Heavy-Duty Diesel Engines	185,000
Class 8 Vocational Trucks and Heavy Heavy-Duty Diesel Engines	435,000

Regulatory Subcategory	UL (miles)
Class 7 Tractors and Medium Heavy-Duty Diesel Engines	185,000
Class 8 Tractors and Heavy Heavy-Duty Diesel Engines	435,000

(ii) Calculate the total credits generated in a model year for each regulatory subcategory using the following equation:

Total regulatory subcategory MY credits = Σ Engine family credits within each regulatory subcategory

(e) *Additional credit provisions*—(1) *Advanced technology credits.* Manufacturers of heavy-duty pickup trucks and vans, vocational trucks and tractors showing improvements in CO_2 emissions and fuel consumption using hybrid vehicles, vehicles equipped with Rankine-cycle engines, electric vehicles and fuel cell vehicles are eligible for advanced technology credits that may be applied to any heavy-duty vehicle or engine subcategory consistent with sound engineering judgment as follows:

(i) *Heavy-duty vocational trucks and truck tractors.* (A) For hybrid vehicles with regenerative braking (or the equivalent) and energy storage systems and for hybrids that incorporate power take-off (PTO) systems, calculate the advanced technology credits as follows:

(*1*) Measure the effectiveness of the hybrid system by simulating the chassis test procedure applicable for each type of hybrid vehicle under 40 CFR part 1037.

(*2*) The effectiveness of the hybrid system is measured using chassis testing against an equivalent conventional vehicle. For purposes of this paragraph (e), a conventional vehicle is considered to be equivalent if it has the same footprint, intended service class, aerodynamic drag, and other factors not directly related to the hybrid 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 hybrid vehicle is considered Vehicle B. EPA may specify an alternate test if the hybrid vehicle includes a power take-off system.

(*3*) The benefit associated with the hybrid 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 x 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 hybrid vehicles, respectively.

GEM Fuel Consumption Result B is the estimated gallons per 1000 ton-mile rate resulting from modeling the emissions of the hybrid vehicle as specified in 40 CFR 1037.520 and § 535.6(b) and (c).

(*4*) Calculate the benefit in credits using the equation in paragraph (d)(9) of this section and replacing the term (Std-FEL) with the benefit.

(B) For Rankine Cycle engines, determine the emission performance benefit according to 40 CFR 1036.615 and convert to an equivalent fuel consumption benefit value. Calculate fuel consumption credits in gallons utilizing the credit equation in paragraph (d)(9) of this section and replacing the term (Std-FCL) with the fuel consumption benefit value.

(C) For electric and fuel cell vehicles, determine the emission performance benefit according to 40 CFR 1037.610 and convert to an equivalent fuel consumption benefit value. Calculate fuel consumption credits in gallons utilizing the credit equation in paragraph (d)(9) of this section and replacing the term (Std-FEL) with the fuel consumption benefit value.

(ii) *Heavy-duty pickup trucks and vans.* (A) For model year 2013, manufacturers may generate advanced technology credits for electric and zero emissions vehicles. Advanced technology credits for electric and zero emissions vehicles may be earned voluntarily as an alternative to generating credits for the manufacturer's entire fleet. Advanced technology credits for electric and zero emissions vehicles are not limited for use within the heavy-duty pickup truck and van regulatory category. Advanced technology credits generated for electric and zero emission vehicles in model year 2013 are treated as though they were generated in model year 2014 for purposes of credit life.

(B) In model years 2014 and later, a manufacturer may choose to calculate credits for its entire fleet as specified in paragraph (a)(8) of this section or may choose to exclude its electric vehicles and zero emissions vehicles from the fleet and calculate the credits for these vehicles separately as advanced technology credits. In this case, the manufacturer may gain credits for its fleet without its electric and zero emissions vehicles and gain the advanced technology credits for these vehicles. Advanced technology credits for electric and zero emissions vehicles are not limited for use within the heavy-duty pickup truck and van regulatory category.

(2) *Innovative technology credits.* EPA allows manufacturers to generate credits consistent with the provisions of 40 CFR 86.1866–12(d) for introducing innovative technology in heavy-duty vehicles for reducing greenhouse gas emissions. Upon identification from EPA of a manufacturer seeking to obtain innovative technology credits in a given model year, NHTSA may adopt the same amount of fuel consumption credits into its program. Such credits must remain within the same regulatory subcategory in which the credits were generated. NHTSA will adopt these fuel consumption credits depending upon whether:

(i) The technology has a direct impact upon reducing fuel consumption performance;

(ii) The manufacturer has provided sufficient information to make sound engineering judgments on the impact of the technology in reducing fuel consumption performance; and

(iii) Credits will be accepted on a one-for-one basis expressed in terms of gallons.

§ 535.8 Reporting requirements.

(a) *General Requirements*—(1) *Required reports.* For the each model year, manufacturers must submit a pre-certification compliance report, an end-of-the-year report, a final report and supplemental reports (if needed) to the Administrator for each regulatory category and regulatory subcategory of heavy-duty trucks and engines as identified in § 535.3.

(2) *Report deadlines.* Reports required by this part for each model year 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 the report is submitted to the Administrator.

(i) *Pre-certification compliance report for heavy-duty pickup truck and van.* (A) For model year 2013 through 2015, a manufacturer choosing to voluntarily comply must submit a pre-certification compliance report for the given model year and, to the extent possible, the two subsequent model years. The report must be sent before the certification of any applicable test group and no later than December 31 of the calendar year before the given model year. For example, the pre-certification compliance report for model year 2014 must be submitted no later than December 31, 2013 and must contain fuel consumption information for vehicles manufactured for model years 2014 to 2016, to the extent possible.

(B) For model years 2016 and later, a manufacturer complying with mandatory standards must submit a pre-certification compliance report for the given model year and, to the extent possible, the two subsequent model years. The report must be sent before the certification of any applicable test group and no later than December 31 of the calendar year two years before the given model year. No report is required for model years 2016 and 2017 if the manufacturer voluntarily complied in model years 2014 and 2015 and if the manufacturer has subsequently provided accurate information regarding its 2016 and 2017 model year fleets in its prior submissions. For example, the pre-certification compliance report for model year 2016 must be submitted no later than December 31, 2013 and must contain fuel consumption information for vehicles manufactured for model years 2016 to 2018, to the extent possible, but if the manufacturer has already provided the required information in its model year 2014 report, no submission would be required for model year 2016.

(ii) *Pre-certification compliance report for heavy-duty vocational trucks, truck tractors and heavy-duty engines.* For model years 2013 and later, a manufacturer complying with voluntary and mandatory standards must submit a pre-certification compliance report for the given model year. The report must be sent before the certification of any applicable vehicle or engine family and no later than December 31 of the calendar year two years before the given model year. No report is required for model years 2016 and 2017 if the manufacturer voluntarily complied in model years 2014 and 2015 and if the manufacturer has subsequently provided accurate information regarding its model years 2016 and 2017 fleets in its prior submissions. For example, the pre-certification compliance report for model year 2016 must be submitted no later than December 31, 2013 and must contain fuel consumption information for vehicles manufactured for model years 2016 to 2018, to the extent possible, but if the manufacturer has already provided the required information in its model year 2014 report, no submission would be required for model year 2016.

(iii) *End-of-the-year-report for all heavy-duty trucks.* A manufacturer complying with voluntary and mandatory standards must submit an end-of-the-year report for each model year. This report must be submitted 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 end-of-the-year report for model year 2014 must be submitted no later than April 1, 2015.

(A) Upon notification from EPA, NHTSA may waive the requirement to send the end-of-the year report, conditioned upon the manufacturer contacting EPA by letter to certify that the final report will be sent on time. NHTSA will not waive this requirement for a manufacturer that has a deficit for a given model year or an outstanding deficit from a prior model year.

(B) If a manufacturer expects differences in the information reported between the end-of-the-year report and the final year report, it must provide the most up-to-date projections in the end-of-the-year report and indentify the information as preliminary.

(C) 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.

(iv) *Final report for all heavy-duty trucks.* A manufacturer complying with voluntary and mandatory standards must submit a final report for each model year. This report must be submitted within 270 days after the given model year and no later than October 1 of the next calendar year. For example, the final year report for model year 2014 must be submitted no later than October 1, 2015.

(v) *Supplemental reports.* A manufacturer must submit a supplemental report within 30 days after making a change to an application for certification with EPA as specified in 40 CFR 1037.225.

(b) *General contents of reports.* (1) Each report submitted by a manufacturer must include the general information identified in this paragraph (b) and, for each regulatory category of vehicles, include the information required in paragraphs (c), (d), and (e) of this section as applicable to each category. The following general information is required for each report:

(i) A designation identifying the report as a pre-certification compliance report, end-of-the-year report, final year report or a supplemental report, as appropriate;

(ii) The name of the manufacturer submitting the report;

(iii) The full name, title, and address of the official responsible for preparing the report;

(iv) The model year; and

(v) The documents the manufacturer plans to incorporate by reference as specified in paragraph (g) of this section.

(2) For model years 2014 and 2015, a manufacturer must follow the instructions on the NHTSA Web site at *http://www.nhtsa.gov* for submitting reports electronically or download a form containing the format and instructions for each report. Electronic submissions must be uploaded to the NHTSA Web site by the required deadlines specified in paragraph (a) of this section.

(3) For model years 2016 and later, manufacturers must submit reports electronically through the NHTSA Web site at *http://www.nhtsa.gov.*

(i) Each manufacturer must register electronically in advance of submitting its first report to obtain a unique and private username, password, and account for accessing the Web site and entering data.

(ii) Electronic reports submitted through the NHTSA Web site must include all the required information specified in paragraphs (b) through (e) of this section to be accepted.

(4) Manufacturers must submit a request for confidentiality with each electronic report 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. Confidential information shall be treated according to paragraph (i) of this section.

(i) For any 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 provide evidence in its request for confidentiality to justify that:

(A) The item is within the scope of 5 U.S.C. 552(b)(4) and 15 U.S.C. 2005(d)(1);

(B) The disclosure of such as item would result in significant competitive damage;

(C) The period during which the item must be withheld to avoid that damage; and

(D) How earlier disclosure would result in that damage.

(ii) NHTSA shall make reports available to the public as specified in paragraph (h) of this section.

(c) *Pre-certification compliance report.* Each pre-certification compliance report must comply with the provisions in this paragraph (c) as applicable to each regulatory subcategory of vehicles or, alternatively, manufacturers may provide copies of any pre-certification documents including the applications for certification and pre-model year reports that are sent to EPA as a substitute as long as those documents contain equivalent fuel consumption information for each carbon-related value. In either case, NHTSA may ask a manufacturer to provide additional information if necessary to verify the fuel consumption requirements of this regulation.

(1) *Pre-certification compliance report for heavy-duty pickups and vans.* (i) For each vehicle configuration (defined by payload, towing capacity and drivetrain configuration) that makes up the manufacturer's combined fleet of heavy-duty pickups and vans as determined by § 535.5(a)(2) for a given model year, identify:

(A) The final fuel consumption standards;

(B) Final production volumes;

(C) Workfactors;

(D) Payload;

(E) Towing capacity;

(F) Existence of 4-wheel drive (indicate yes or no);

(G) Gross Vehicle Weight Rating; and

(H) Gross Combined Weight Rating.

(ii) For the manufacturer's combined fleet of heavy-duty pickups and vans as determined by § 535.5(a)(3), for a given model year, identify the projected final fleet average fuel consumption standard.

(iii) For each vehicle in the test groups used to determine the manufacturer's fleet average fuel consumption value as determined by § 535.6(a), for a given model year, identify:

(A) The final fuel consumption value;

(B) Make and model designation;

(C) Final production volumes for each make and model designation;

(D) Payload;

(E) Towing capacity;

(F) Existence of 4-wheel drive (indicate yes or no);

(G) Gross Vehicle Weight Rating;

(H) Gross Combined Weight Rating;

(I) Loaded vehicle weight;

(J) Equivalent test weight;

(K) Engine displacement, liters;
(L) SAE net rated power, kilowatts;
(M) SAE net horsepower;
(N) Engine code;
(O) Fuel system (number of carburetor barrels or, if fuel injection is used, so indicate);
(P) Fuel consumption control system;
(Q) Transmission class;
(R) Number of forward speeds;
(S) Existence of overdrive (indicate yes or no);
(T) Total drive ratio;
(U) Axle ratio; and
(V) If available, any advanced or innovative technology that reduces fuel consumption.

(iv) For the manufacturer's combined fleet of heavy-duty pickups and vans as determined by § 535.6(a), for a given model year, identify the projected fleet average fuel consumption value.

(v) Identify the projected final U.S.-directed production volumes for:

(A) The vehicle configurations that make up the manufacturer's combined fleet of heavy-duty pickups and vans for a given model year;

(B) The vehicles in each test group used to determine the manufacturer's fleet average fuel consumption value for a given model year; and

(C) Attest to the authenticity and accuracy of each projected final production volume and provide the signature of an officer (a corporate executive of at least the rank of Vice President) designated by the corporation. The signature of the designated officer shall constitute a representation by the required attestation. Such attestation shall constitute a representation by the manufacturer that the manufacturer has established reasonable, prudent procedures to ascertain and provide production data that are accurate and authentic in all material respects and that these procedures have been followed by employees of the manufacturer involved in the reporting process.

(vi) For flexible fueled, dedicated fuel and advanced technology vehicles including electric vehicles, hybrid vehicles, plug-in hybrid vehicles and fuel cell vehicles identify:

(A) Make and model designation;
(B) Projected final production volumes; and
(C) The method that will be used to calculate the fuel consumption values.

(vii) Report information on the manufacturer's projected fuel consumption credits:

(A) Report a projection of the credits and balances to be generated for the fleet for each model year;

(B) Report and provide a description of the various planned credit flexibility options that will be used to comply with the standards, if necessary, including the amount of credit the manufacturer intends to generate from innovative or advanced technologies, and for voluntary compliance in model years 2014 or 2015, or by trade; and

(C) If a credit shortfall is generated (or projected to be generated) at the end of the model year, a manufacturers must submit the compliance plan required by § 535.9(a)(6) in its pre-certification compliance report with the most up-to-date information demonstrating how the manufacturer will comply with the fleet average fuel consumption standard by the end of the third year after the shortfall occurs.

(viii) Manufacturers using the low volume exclusion and exempting 2 percent of their total production in accordance with § 535.5(a)(6) must provide a plan describing how the exclusion will be used, including a description and a production volume for each excluded vehicle.

(ix) Manufacturers choosing early compliance must submit a statement in the pre-certification compliance report announcing their intent to comply with fuel consumption standards and must attest to understanding that compliance is mandatory thereafter for each model year until 2018.

(2) *Pre-certification compliance reports for vocational trucks and truck tractors.* (i) For each regulatory category and subcategory, describe the annual fuel consumption credit activities under NHTSA's ABT program by:

(A) The balance of credits in each regulatory category and subcategory;

(B) The fuel consumption credits that you plan to trade as described in § 535.7.

(C) A description of the various planned credit flexibility options that will be used to comply with the standards, if necessary, including the amount of credit the manufacturer intends to generate from innovative or advanced technologies, and for voluntary compliance in model years 2014 or 2015, or by trade; and

(D) If a credit shortfall is generated (or projected to be generated) at the end of the model year, a manufacturer must submit the compliance plan required by § 535.9(a)(6) in its pre-certification compliance report with the most up-to-date information demonstrating how the manufacturer will comply with the fleet average fuel consumption standard by the end of the third year after the shortfall occurs.

(ii) Identify the projected final U.S.-directed production volumes for:

(A) Each of the manufacturer's combined fleets of heavy-duty vocational trucks and trucks tractors for the model year;

(B) Each regulatory subcategory of heavy-duty vocational trucks and trucks tractors for the model year;

(C) The vehicles in each vehicle family used to determine the manufacturer's fleet average fuel consumption value for the model year; and

(D) Attest to the authenticity and accuracy of each projected final production volume and provide the signature of an officer (a corporate executive of at least the rank of Vice President) designated by the corporation. The signature of the designated officer shall constitute a representation by the required attestation. Such attestation shall constitute a representation by the manufacturer that the manufacturer has established reasonable, prudent procedures to ascertain and provide production data that are accurate and authentic in all material respects and that these procedures have been followed by employees of the manufacturer involved in the reporting process.

(iii) Report the methodology which the manufacturer plans to use to comply with EPA's N_2O and CH_4 emission standards. If the manufacturer plans to choose an option which could increase its CO_2 emission, it must report any calculated increases in its emission values that are associated directly with these gases. It must also report any increases in CO_2 emissions in equivalent terms of fuel consumption.

(iv) Manufacturers choosing early compliance must submit a statement in the pre-certification compliance report announcing their intent to comply with fuel consumption standards and must attest to understanding that compliance is mandatory thereafter for each model year until 2018.

(v) For each regulatory subcategory of vocational trucks and truck tractors identify:

(A) The vehicle-family and subfamily designations selected in accordance with 40 CFR part 1037, subpart C;

(B) The fuel consumption standards that would otherwise apply to each vehicle family;

(C) The vehicle family fuel consumption FELs (gallons per 1,000 ton-mile);

(D) The projected final U.S.-directed production volumes for the model year as a total for the subcategory and for each vehicle family;

(E) The useful life value for each vehicle family; and

(F) The calculated projected final surplus or shortfall fuel consumption credits for each vehicle family. If you have a projected shortfall credit balance for a regulatory subcategory in the given model year, specify which vehicle families (or certain subfamilies with the vehicle family) have a credit shortfall for the year. Consider for example, a manufacturer with three vehicle families ("A", "B", and "C") in a given regulatory subcategory. If family A generates enough credits to offset the shortfall credits of family B but not enough to also offset the credit shortfall 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 shortfall for the model year, provided it designates family C as having a shortfall for the model year.

(vi) For vehicles in each vehicle family belonging to the vocational vehicle regulatory subcategories identify:

(A) The FEL for each family and the fuel consumption performance for each vehicle in the family.

(B) Intended commercial use.

(C) Gross Vehicle Weight Rating.

(D) Rolling resistance coefficient for the tires.

(E) Any aerodynamic features.

(F) Any weight reduction features.

(G) Any drivetrain (*i.e.*, axles, accessories, and transmission) improvements that reduce emissions and fuel consumption.

(H) Any idle reduction technologies.

(I) Any hybrid powertrains including hydraulic, electric, and plug-in electric.

(J) The model types and projected final production of all alternate and dedicated fueled vehicles.

(vii) For vehicles in each vehicle family belonging to the truck tractor regulatory subcategories identify:

(A) The FEL for each family and the fuel consumption performance for each vehicle in the family.

(B) Aerodynamic drag coefficient (Cd).

(C) Steer tire rolling resistance (kg/metric ton).

(D) Drive tire rolling resistance (kg/metric ton).

(E) Weight reduction (lbs).

(F) Extended idle reduction (g/ton-mile).

(G) Vehicle speed limiter.

(viii) For flexible fueled, dedicated fuel and advanced technology vehicles including electric vehicles, hybrid vehicles, plug-in hybrid vehicles and fuel cell vehicles in each vehicle family and regulatory subcategory identify:

(A) Make and model designation;

(B) Projected final production volumes; and

(C) The method that will be used to calculate the fuel consumption values.

(3) *Pre-certification compliance reports for heavy-duty engines.* (i) For each regulatory category and subcategory, describe the annual fuel consumption credit activities under NHTSA's ABT program by:

(A) The balance of credits in each regulatory category and subcategory;

(B) The fuel consumption credits that you plan to trade as described in § 535.7;

(C) A description of the various planned credit flexibility options that will be used to comply with the standards, if necessary, including the amount of credit the manufacturer intends to generate from innovative or advanced technologies, and for voluntary compliance in model years 2014 or 2015, or by trade; and

(D) If a credit shortfall is generated (or projected to be generated) at the end of the model year, a manufacturer must submit the compliance plan required by § 535.9(a)(6) in its pre-certification compliance report with the most up-to-date information demonstrating how the manufacturer will comply with the fleet average fuel consumption standard by the end of the third year after the shortfall occurs.

(ii) Identify the projected final U.S.-directed production volumes for:

(A) The manufacturer's combined fleet of heavy-duty engines for the model year;

(B) Each regulatory subcategory of heavy-duty engines for the model year;

(C) The vehicles in each vehicle family used to determine the manufacturer's fleet average fuel consumption value for the model year; and

(D) Attest to the authenticity and accuracy of each projected final production volume and provide the signature of an officer (a corporate executive of at least the rank of Vice President) designated by the corporation. The signature of the designated officer shall constitute a representation by the required attestation. Such attestation shall constitute a representation by the manufacturer that the manufacturer has established reasonable, prudent procedures to ascertain and provide production data that are accurate and authentic in all material respects and that these procedures have been followed by employees of the manufacturer involved in the reporting process.

(iii) Report the methodology which the manufacturer plans to use to comply with EPA's N_2O and CH_4 emission standards. If the manufacturer plans to choose an option which could increase its CO_2 emission, it must report any calculated increases in its emission values that are associated directly with these gases. It must also report any increases in CO2 emissions in equivalent terms of fuel consumption.

(iv) Manufacturers choosing early compliance must submit a statement in the pre-certification compliance report announcing their intent to comply with fuel consumption standards and must attest to understanding that compliance is mandatory thereafter for each model year until 2018.

(v) For each engine regulatory subcategory, identify:

(A) The engine-family and subfamily designations selected in accordance with 40 CFR part 1036, subpart C;

(B) The fuel consumption standards that would otherwise apply to each engine family;

(C) The engine family fuel consumption FCLs (gallons per 100 bhp-hr);

(D) The projected final U.S.-directed production volumes for the model year as a total for the subcategory and for each engine family;

(E) The useful life value for each engine family; and

(F) The calculated projected final surplus or shortfall fuel consumption credits for each engine family. If you have a projected shortfall credit balance for a regulatory subcategory in the given model year, specify which engine families (or certain subfamilies with the vehicle family) have a credit shortfall for the year. Consider for example, a manufacturer with three engine families ("A", "B", and "C") in a given regulatory subcategory. If family A generates enough credits to offset the shortfall credits of family B but not enough to also offset the credit shortfall 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 shortfall for the model year, provided it designates family C as having a shortfall for the model year.

(vi) For each engine in an engine family, report the following technologies and information if existing:

(A) Engine friction reduction.

(B) Coupled cam phasing.

(C) Cylinder deactivation.

(D) Diesel engine.

(E) Baseline engine.

(F) Turbochargers.

(G) Low temperature exhaust gas recirculation.

(H) Engine friction reduction.

(I) Selective catalytic reduction (SCR).

(J) Improved combustion process.

(K) Reduced parasitic loads.

(d) *End-of-the-year and final reports.* After the end of each model year, manufacturers must provide to the Administrator copies of the end-of-the-year and final reports sent to EPA specified in 40 CFR 1037.730. Manufacturer must also provide equivalent fuel consumption information for each CO_2 value and the specified information described in paragraphs (d)(1) and (2) of this section. In either case, NHTSA may ask a manufacturer to provide additional information if necessary to verify the fuel consumption requirements of this regulation.

(1) Report and provide a description of the various credit flexibility options that were used to comply with the standards and, if necessary, include the amount of credits the manufacturer acquired from innovative or advanced technologies, from voluntary compliance with model years 2014 or 2015, or by trade.

(2) Report the methodology which the manufacturer used to comply with N_2O and CH_4 emission standards. If the manufacturer chose an option which increased its CO_2 emission, it must report the calculated increases in its emission values that were associated directly with these gases. It must also report the increase in CO_2 emissions in equivalent terms of fuel consumption.

(e) *Supplemental reports.* (1) A manufacturer must submit a supplemental report to the Administrator at any time the manufacturer amends an application for certification with EPA, in accordance with 40 CFR 1036.225 and 40 CFR 1037.225.

(2) The supplemental report must include the changes that the manufacturer makes to an application for certification.

(f) *Additional reporting provisions.* (1) *Small business exemption.* Vehicles produced by small business manufacturers are exempted from the requirements of this regulation but are required to provide to EPA and NHTSA a statement explaining how they qualify as a small business as defined by the Small Business Administration at 13 CFR 121.201. The statement must be submitted to the Administrators of EPA and NHTSA and must be submitted no later than December 31 of the calendar year before the model year begins.

(2) *Heavy-duty vehicle off-road exclusion.* Heavy-duty vehicles intended to be used extensively in off-road environments such as forests, oil fields, and construction sites may be exempted from the requirements of this part if EPA and NHTSA approve the exemption. This provision applies to all heavy-duty vehicles except for vocational trucks and truck tractors meeting the qualifications specified in 49 CFR 523.2 that are already exempted. Manufacturers seeking an exemption must send the request to the Administrators of EPA and NHTSA explaining the basis for defining their vehicle for exclusive use as an off-road vehicle.

(g) *Incorporation by reference.* (1) A manufacturer may incorporate by reference in a report required by this part any document other than a report, petition, or application, or portion thereof submitted to any Federal department or agency more than two model years before the model year of the applicable report.

(2) A manufacturer that incorporates by references a document not previously submitted to the National Highway Traffic Safety Administration shall append that document to the report.

(3) A manufacturer that incorporates by reference a document shall clearly identify the document and, in the case of a document previously submitted to the National Highway Traffic Safety Administration, indicate the date on which and the person by whom the document was submitted to this agency.

(h) *Public inspection of information.* (1) Except as provided in paragraph (i) of this section, any person may inspect the information and data submitted by a manufacturer under this part in the docket section of the National Highway Traffic Safety Administration. Any person may obtain copies of the information available for inspection under this section in accordance with the regulations of the Secretary of Transportation in 49 CFR part 7.

(2) In model year 2016, summary reports containing the electronic data submitted by manufacturers, except as provided in paragraph (i) of this section, will be made publically available.

(i) *Confidential information.* (1) Information will not be made available for public inspection under paragraph (h) of this section if confidentiality is granted in accordance with section 505 of the Act and 5 U.S.C. 552(b) or while the manufacturer's request in accordance with paragraph (b)(4) is under consideration.

(2) When the Administrator denies a manufacturer's request under paragraph (b)(4) of this section for confidential treatment of information, the Administrator gives the manufacturer written notice of the denial and the reasons for it. Public disclosure of the information is not made until after the ten-day period immediately following the giving of the notice.

(3) After giving written notice to a manufacturer and allowing ten days, when feasible, for the manufacturer to respond, the Administrator may make available for public inspection any information submitted under this part, except for information submitted by the manufacturer on its emission control and fuel-system operations and the design of system components including any information to read, record, and interpret all the information broadcast by a vehicle's onboard computers and electronic control units, that is relevant to a proceeding under the Act, including information that was granted confidential treatment by the Administrator pursuant to a request by the manufacturer under paragraph (b)(4) of this section.

§ 535.9 Enforcement approach.

(a) *Compliance.* (1) NHTSA assesses compliance with fuel consumption standards each year, utilizing the certified and reported fuel consumption data provided by the Environmental Protection Agency for enforcement of the heavy-duty truck fuel efficiency program established pursuant to 49 U.S.C. 32902(k).

(2) Credit values in gallons are calculated based on the final CO_2 emissions and fuel consumption data submitted by manufacturers and verified/validated by EPA.

(3) If a manufacturer's regulatory subcategory fuel consumption in any model year is found to exceed the applicable standard(s), NHTSA identifies surplus credits in a manufacturer's account for that model year and regulatory subcategory in the appropriate amount by which the manufacturer has exceeded the applicable standard(s).

(4) If a manufacturer's engines or vehicles in a particular regulatory subcategory are found not to meet the applicable fuel consumption standard(s), calculated as a credit shortfall, NHTSA will provide written notification to the manufacturer that it has failed to meet a particular regulatory subcategory standard. The manufacturer will be required to confirm the performance shortfall and must either: Submit a plan indicating how it will allocate existing credits or earn, and/or acquire by trade credits; or will be liable for a civil penalty as determined in paragraph (b) of this section. The manufacturer must submit a plan within 60 days of receiving agency notification.

(5) Credit shortfall within a regulatory subcategory 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.

(6) 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 sufficient credits to offset the subject credit shortfall. 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.

(7) For purposes of this part, 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.

(8) 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.

(9) 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 will initiate civil penalty proceedings.

(b) *Civil penalties*—(1) *Generally*. The provisions of 5 U.S.C. 554, 556, and 557 do not apply to any proceedings conducted pursuant to this section.

(2) *Determination of non-compliance*. NHTSA Enforcement will make a determination of non-compliance 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. If NHTSA Enforcement determines that a regulatory subcategory of vehicles or engines fails to comply with the applicable fuel consumption standard, the chassis, vehicle or engine manufacturer shall be subject to a civil penalty of not more than $37,500.00 per vehicle or engine. NHTSA may adjust this civil penalty amount to account for inflation. Any such violation as defined in § 535.4 shall constitute a separate violation with respect to each vehicle or engine within the applicable regulatory subcategory.

(3) *Maximum civil penalty limit*. 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 subcategory.

(4) *Factors for determining proposed penalty amount*. In determining the amount of any civil penalty proposed to be assessed under this section, NHTSA Enforcement 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 standard, the estimated cost to comply with the regulation and applicable standard, the quantity of vehicles or engines not complying, the effect of the penalty on the violator's ability to continue in business, and civil penalties paid under Clean Air Act section 205 (42 U.S.C. 7524) for non-compliance for the same vehicles or engines.

(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 reports 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) NHTSA has authority to assess a civil penalty for any violation of this part under 49 U.S.C. 32902(k). The penalty may not be more than $37,500.00 for each violation.

(ii) The Chief Counsel may issue a Notice of Violation to a party. The Notice of Violation will contain the following information:

(A) The name and address of the party;

(B) The alleged violation and the applicable fuel consumption standards violated;

(C) The amount of the proposed penalty;

(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, the party has the right to a hearing 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.

(iii) 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 part or an employee of the party.

(iv) If a party submits a written request for a hearing as provided in the Notice of Violation or an amount agreed on in compromise within 30 days of the date shown on the Notice of Violation, 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, the Hearing Officer shall hear the case.

(ii) The Hearing Officer is solely responsible for the case referred to him or her. The Hearing Officer has no other responsibility, direct or supervisory, for the investigation of cases referred for the assessment of civil penalties.

(iii) The Hearing Officer decides each case on the basis of the information before him or her, and must have no prior connection with the case.

(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 the paragraph (b)(9) of this section;

(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 shall be held telephonically. In 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 3 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.

(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. The Hearing Officer may allow the party to respond to any such evidence submitted.

(vii) 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, the Hearing Officer prepares the decision in the case.

(viii) 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) *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. The decisions 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, the effect of the penalty on the violator's ability to continue in business, and civil penalties paid under Clean Air Act section 205 (42 U.S.C. 7524) for non-compliance for the same vehicles or engines shall be taken into account. The assessment of a civil penalty by the Hearing Officer shall be set forth in an accompanying final order.

(ii) If the Hearing Officer assesses civil penalties in excess of $250,000,000, the Hearing Officer's decision contains a statement advising the party of the right to an administrative appeal to the Administrator. 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.

(iv) There shall be no administrative appeals of civil penalties of less than $250,000,000.

(13) *Appeals of civil penalties in excess of $250,000,000.* (i) A party may appeal the Hearing Officer's order assessing civil penalties over $250,000,000 to the Administrator within 21 days of the date of the issuance of the Hearing Officer's order.

(ii) The Administrator will affirm the decision of the Hearing Officer unless the Administrator finds that the Hearing Officer's decision was unsupported by the record as a whole.

(iii) If the Administrator finds that the decision of the Hearing Officer was unsupported, in whole or in part, then the Administrator may:

(A) Assess or 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.

Dated: October 25, 2010.

Lisa P. Jackson,

Administrator, Environmental Protection Agency.

Dated: October 25, 2010.

Ray LaHood,

Secretary, Department of Transportation.

[FR Doc. 2010–28120 Filed 11–29–10; 8:45 am]

BILLING CODE 6560–50–P